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THE TREPHINERS OF BLANCHE BAY, NEW BRITAIN, THEIR INSTRUMENTS AND METHODS

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THE surgical efforts of the native 'healers' of New Britain are justly entitled to recognition and admiration, because of their apparent rational conception and development.

Though the primary object of this contribution is to record the details of trepanation, with descriptions and illustrations of the instruments used by the natives of the Blanche Bay district, it is permissible to draw attention to some relevant associated facts.

Trephining is as old as surgery itself. The evidence of prehistoric trephining stands conclusive, even if the reasons for the institution of the measure must remain in the realm of conjecture. Some respect, certainly a mixed respect, must be felt for those who, without a precise knowledge of brain function and in the absence of anæsthesia and asepsis, undertook the hazardous assault on the cranium. Recovery was not an uncommon result, paleopathologists agree. The trepanations of a later, though scarcely advanced, period held out no better prospect of recovery, Hudson's figures[3] showing a mortality of 75 per cent in the thirty-two operations carried out at St. George's and Guy's Hospitals during the period 1870–77. This leaves us totally unprepared for the sharply contrasting estimates of Parkinson[2] and Crump,[1] who claim that over 70 per cent survived the operations performed in the Gazelle Peninsula and the neighbouring Duke of York Islands (*Fig.* 1). It is hard to realize that these primitive native surgeons were ahead of their English contemporaries at that time.

FIG. 1.—Map of New Britain and surrounding islands.

Analyses of primitive methods permit scientific guesses to be made regarding some of the steps which intervene between Shamanism and surgery; in this instance it will be possible to show a knowledge of technique which may well correspond to an earlier phase of our own.

Nearly sixty years ago in the Blanche Bay district inter-tribal skirmishes were common and the issue was often decided by sling-stone warfare. The stones were thrown with great force and accuracy, and frequently caused fractures of the skull. Fractures in the frontal and parietal regions predominated, though discretionary retreats at times entailed fractures in the occipital area. An immediate selection of cases suitable for operation was made by the *tene a babait*, literally, " the one who is skilled in healing ". Those who had sustained extensive cerebral damage were rejected.

The surgeon had at his disposal the following instruments* (the native name with its English equivalent is given) (*Figs.* 2–9) :—

Vi (Knife).—This is a piece of bamboo, cut tangentially and shaped to provide a double cutting edge in the upper two-thirds of its total length (12 cm.). The lower third is the wider by 1 cm., and constitutes the handle. (*Fig.* 2.)

Koto (Scraper).—An irregularly shaped piece of igneous rock (7 cm. long, 3·5 cm. broad) with sharp edges. (*Fig.* 3.)

Kaur (Blowpipe).—A hollow cylinder of bamboo, 16 cm. long and 7 mm. in diameter. (*Fig.* 4.)

Kia (Two types: (i) Forceps, (ii) Scoop).—

i. A narrow strip of bamboo 12 cm. long and 6 mm. wide, doubled over to form a pair of forceps.

ii. A piece of coco-nut shell 6·5 cm. long and 2 cm. wide (maximum), fashioned to form a scoop. (*Fig.* 5.)

Takam (Needle).—Sharpened hollow wing bones of the flying fox; illustrated specimens are 9 and 6 cm. long. (*Fig.* 6.)

Kuara or *Aojaoja* (Thread).—Two specimen samples of double-ply threads, sizes corresponding to No. 5 catgut and ooo catgut (British Imperial wire gauge standard). The thread is made from banana fibre, the shoot being split lengthways, the inside well scraped, and then dried in the sun. (*Fig.* 7.)

The *tene a babait* carefully washed the wound with the young milk (*tirip*) of a Makadao coco-nut. Then he made a triangular incision (*Fig.* 10) over the site of the fracture. He scraped away the tissues with a *koto*, *tirip* being continuously poured over the wound. Then he blew inside the wound with a *kaur*, in an attempt to locate the spicules of bone; it was thought that the semi-conscious patient felt more pain when the current of air impinged on the fragments. These were picked out with the *kia*, while scraping and blowing were continued until all pieces were removed. The skin was coapted with needle and thread. Then the following elaborate dressings were placed in position.

First a *tagete* leaf was applied, and over that was laid *palapalao*, the outer layer of the banana flower. Now, *meme na bnai*, a mixture of pepper, lime, and very

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* These instruments are now housed in the Department of Surgery, New Medical School, University of Sydney.

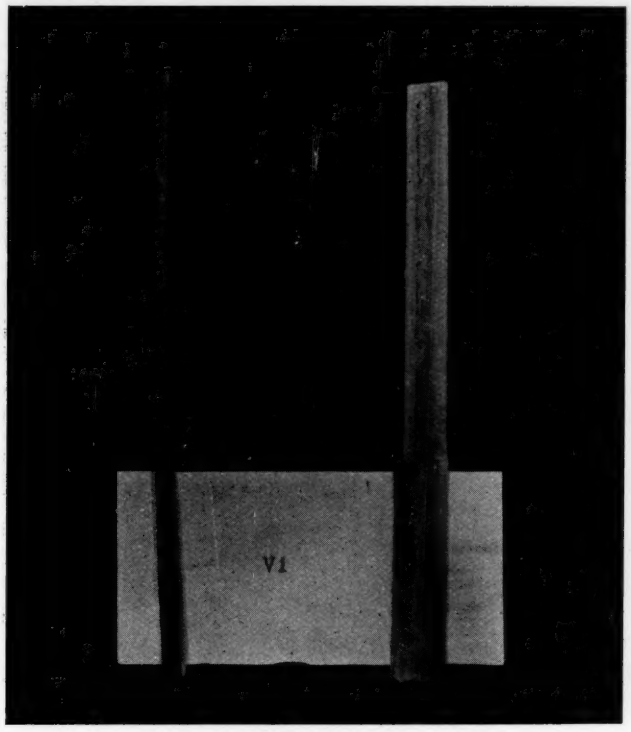

FIG. 2.—*Vi* or knife.

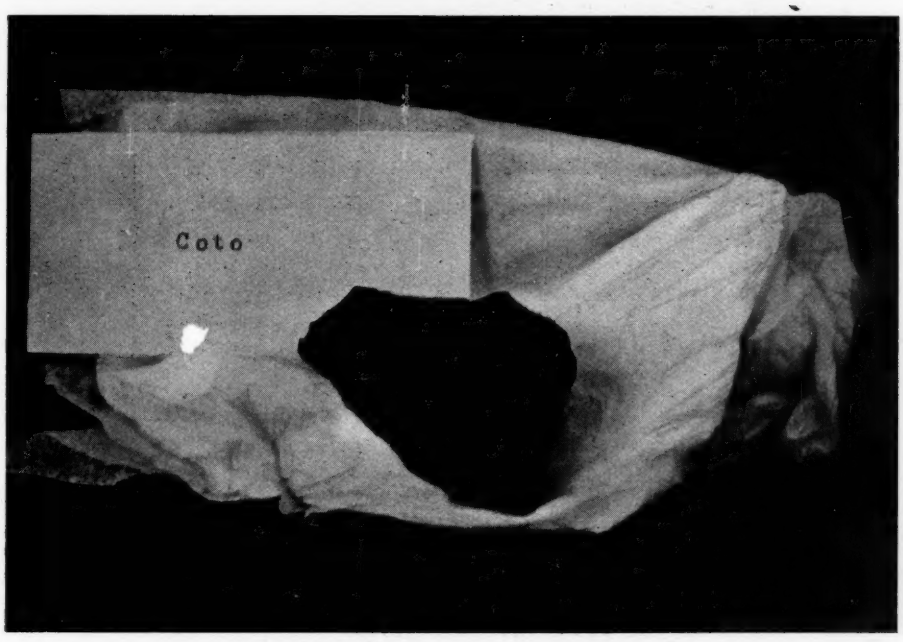

FIG. 3.—*Koto* (or *Coto*) or scraper

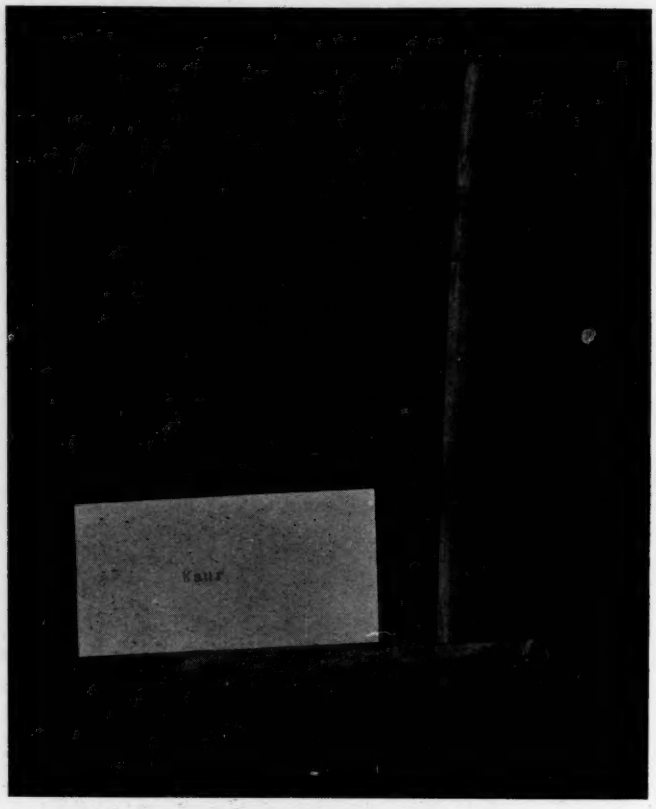

FIG. 4.—*Kaur* or blowpipe.

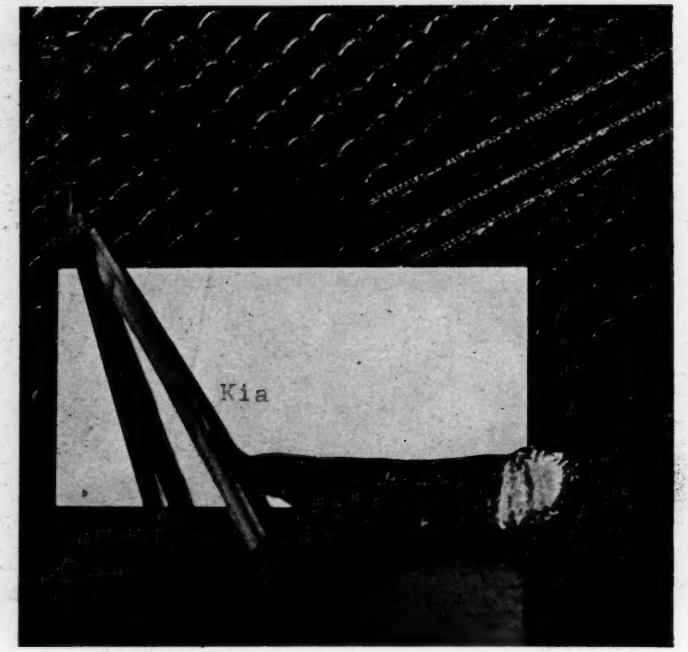

FIG. 5.—*Kia* (two types): (i) forceps; (ii) scoop.

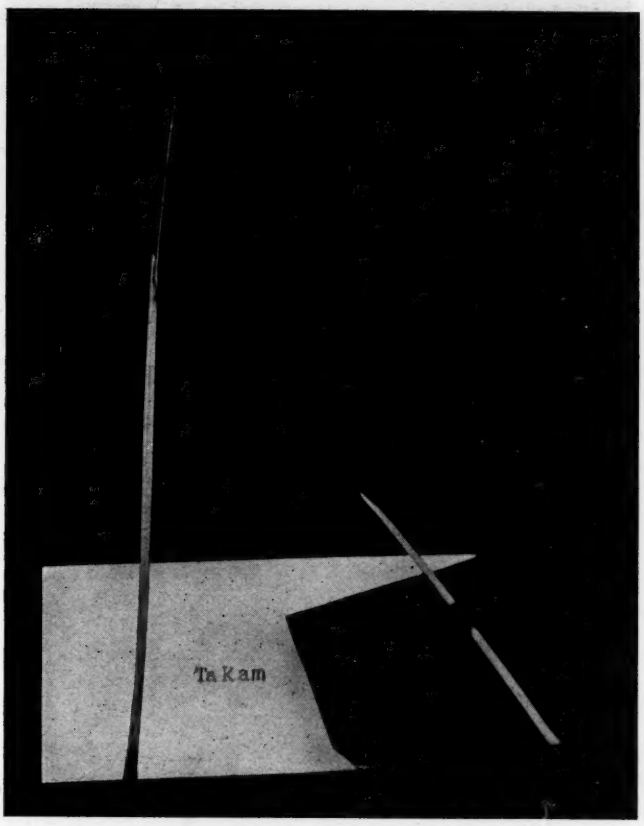

FIG. 6.—*Takam* or needle.

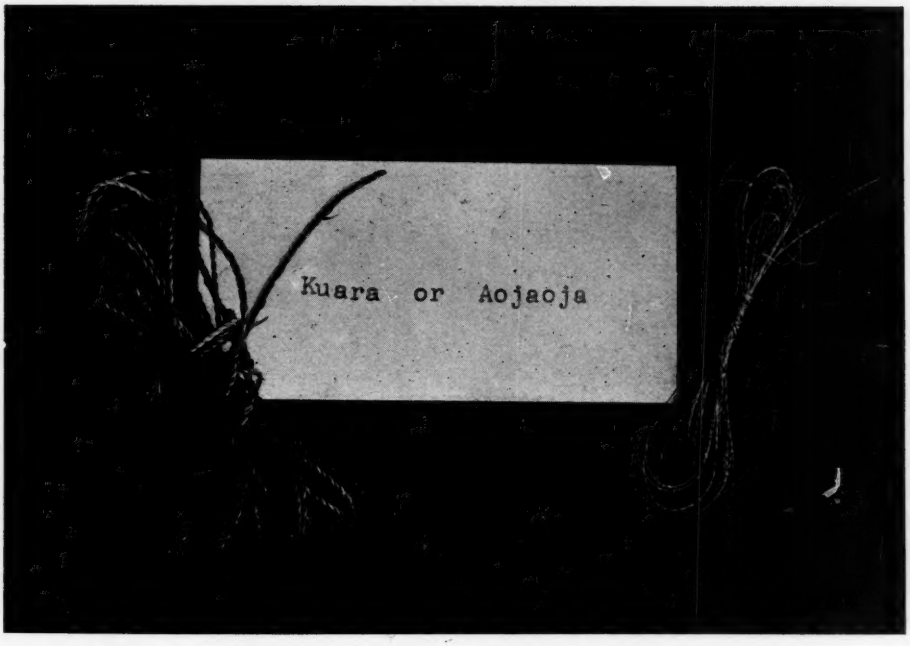

FIG. 7.—*Kuara* (or *Aojaoja*) or thread.

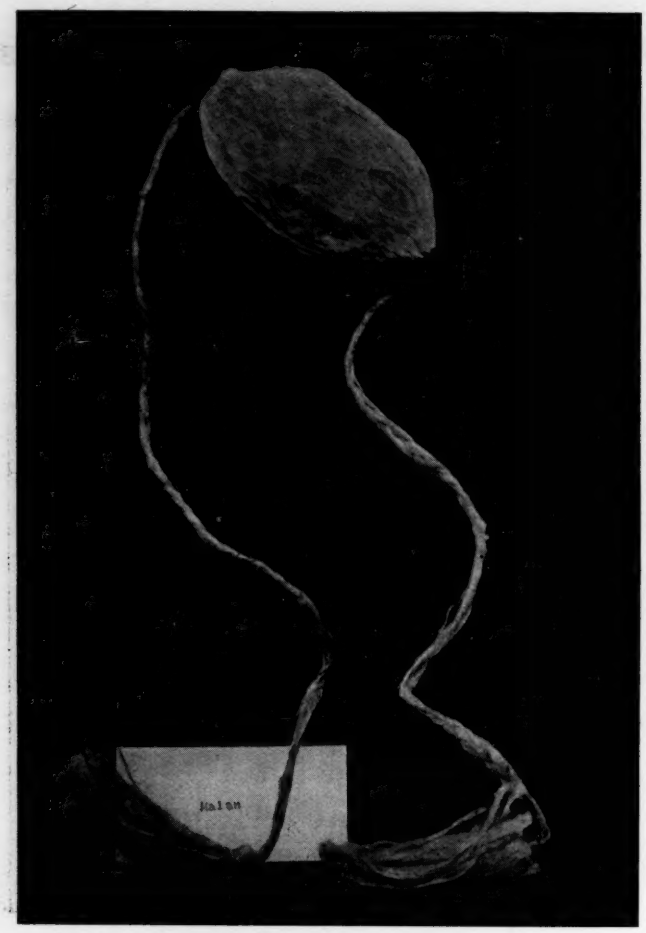

FIG. 8.—*Malan* or dressing pad.

FIG. 9.—The full range of instruments and materials used in trephining by the natives of Gazelle Peninsula, New Britain.

soft young betel nut (*aimim*), which had been chewed together, was spread to exclude air. The entire head was covered with taro leaf (*kumu*) and big round leaves of a bush (*paba*), and finally the *malan* was tied on. The *malan* is an oval dressing pad of *mal* (*Fig.* 8). My specimen is 9·5 cm. long and 5·5 cm. wide. It is backed by two pieces of leaf, and at each end a plaited strap of *ratang*, 42 cm. long, is firmly attached. *Mal* is secured from a small branch of a tree, *mal tuna*. The bark is scraped off, the stick well pounded to loosen the inside, and then the stick is beaten into a broad strip, which can be joined to others by the sap from the same tree.

If the operator found that the brain was slightly damaged, he had no hesitation in scooping out the traumatized portions. The hole was plugged with a piece of red *mal*, which was retained permanently. White *mal* from the tree *mal tuna* was wrapped over the wound and left there until it healed.

FIG. 10.—Showing the triangular incision over the site of the fracture.

After the operation the patient was given soft food, to minimize movements of the jaw and to keep the head quiet. For three days he was not disturbed. Then the dressings were taken down. If pus was found, the sutures were removed, the operation repeated, and fresh dressings applied. After a week or so the patient was given a piece of old coco-nut to chew. Should no pain be felt this was taken as evidence of healing and of the absence of fragments.

Three descriptions of this operation and relevant details have been published. The Rev. J. A. Crump[1] was the first to communicate his observations, his paper being read by Mr. Victor Horsley: "... the man who performs the operation is the wizard or '*tena papait*' of the tribe or district; using a piece of shell or a flake or obsidian for a trephine ... an incision is made over the seat of the fracture, generally in the shape of a Y or V, and then perhaps some loose fragment is picked out with the finger nail, and while assistants hold back the scalp the fractured bone is scraped, cut, and picked away ... all loose pieces having been removed, the scalp is carefully laid down and the wound bandaged. ... The patient is generally insensible from the time of the injury. In five or six days the bandages are renewed and in two or three weeks a complete recovery is the result. The number of deaths is about 20 per cent, most of these resulting from the first injury and not from any complication after the operation ... I am assured that if a patient once becomes conscious he never fails to make a good recovery."

A German surveyor, Mr. R. Parkinson,[2] records his experiences thus: "his instruments are ... a splinter of obsidian, a sharp shark's tooth, or a sharpened mussel shell ... he washes his never very clean hands with the water of a *kubika* (a coco-nut) and with the same water the wound is scrupulously washed ... he now makes a long cut diagonally across the contusion. A thin rattan rope is made fast to a lock of hair ... the scalp covering is slowly and carefully drawn back ... with a sharpened piece of coco-nut the single splinters are carefully drawn out until the brain is visible ... with a sharp object he scrapes around the opening in the roof of the skull so that all sharp corners are removed until the hole is round or elliptical. This is covered over with a small piece of *mal*, or with a small piece

of the heart leaf of a certain banana which is held over a glowing fire for a few moments. Then the flesh of the skull is carefully pulled over the skull into its appointed place. The hair round about the wound is now cut off and finally the whole is washed carefully with the water of a *kubika*. In order to hold the flesh in place and thus ensure healing, a broad plaited net made of strips of rattan is drawn over the skull . . . an old native recited to me thirty-one cases . . . of these twenty-three survived, many of whom were presented to me . . . one of them has been trepanned twice."

The third account was published by the author in 1936[5], and forms the basis for this contribution.

Recently Ford[4] has reviewed the literature dealing with trepanning in Melanesia, and has recorded details and photographs of a trepanned skull obtained from the Blanche Bay district. Among other comments, he states that " . . . the native who was known, survived the operation for many years, as the healing of the bone would confirm . . . the circular opening might easily be taken for the handiwork of a modern European surgeon."

The explanation of the variation in the accounts lies in the fact that the observations were made in different areas. In any case it is very unlikely that the technique would be rigidly uniform. This is in accord with our own experience—the procedure adopted varies with the school, the district, the type of case, and the operator.

There seems to be no doubt that a definite surgical indication conditioned the performance of the operation, though Parkinson mentions that in the southern half of Neu Mecklenburg (New Ireland) " they have advanced still further in surgical practice, in that they call on trepanning for certain illnesses and to relieve pain."

The steps of the operation appear surprisingly orderly, and an examination of the instruments increases our respect for the ingenuity of the *tene a babait*. The post-operative treatment demonstrates fragments of rational nursing, and altogether an unexpectedly high order of surgical acumen is displayed. This receives support from the assertions of Crump and Parkinson, who write of the large percentage of recoveries, although Mrs. Parkinson's experience was the reverse. Mental disturbances (the native word is *long-long*) were occasional complications when recovery took place.

The relation of this primitive operation to Shamanism is partly brought out by consideration of two points. Firstly, the *tene a babait* is the wizard or ' healer ', healing connoting a significance other than therapeutic. In the second place, Parkinson says that charms, *mailan* and *aurur*, were hung on the patient in order to ensure healing.

Here, then, is a reminder of the time when the possible intention was to placate an angry god, this being achieved by operative interference with an affected part. In this way a piece of bone, for example, could become an object of reverence and come to possess an element of religious significance. The possession of one of these ' charms ' by a man being treated for some other condition would, in the event of healing taking place, probably be seized upon as something greater than coincidence.

The final points are these. It has been left to missionaries, anthropologists, and lay observers to uncover this illuminating, if oblique, information on

the history of surgery. There may be other and richer fields awaiting the harvester. Investigations may require a re-assessment, and, what is more important, stimulate a greater interest in some of the hidden milestones of surgical progress.

The author wishes to express his thanks to Mrs. R. Parkinson, of Kavieng, for her invaluable assistance. Her fifty-seven years' experience of New Britain includes a great knowledge of the language and lore. It was through her co-operation that the instruments were secured, Professor Harold R. Dew providing timely financial aid. Mr. R. B. Thistlethwayte, sometime patrol officer at Salamaua, made the helpful translations from Parkinson's work.

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[5] BRODSKY, I., *Ibid.*, 1936, ii, 817.

INTRATHORACIC RECONSTRUCTION OF THE LOWER ŒSOPHAGUS

NOTE ON AN UNSUCCESSFUL CASE

By W. H. OGILVIE, London

The following account of a failure is published because it appears to indicate how success might be attained in a similar case.

CASE REPORT

History.—The patient was a male aged 53. In 1932 he had an attack of typical duodenal ulcer pain, which disappeared with strict diet and did not return. In April, 1936, he began to feel distended and was troubled with hiccup. These symptoms were relieved by alkalis, but returned on several occasions, and in July became distressing. In mid July he first noticed that food appeared to be arrested behind the lower end of the sternum. At first solid food alone gave trouble, but by the end of the month liquids also were arrested, and he was only able to take one or two ounces of fluid at a time. He felt constantly distended, but was unable to bring up wind. He lost a stone in weight between April and July.

A barium meal was arrested at the lower end of the œsophagus. The barium trickled slowly into the stomach, showing an ill-defined filling defect near the cardia.

Œsophagoscopy by Mr. R. J. Cann showed that the cardiac orifice was narrow and rigid, so that the tube could not be passed through it, but the mucous membrane above it appeared normal.

Operation (August, 1936).—

Anæsthetic.—Local: Regional nerve-block of abdominal wall. Splanchnic block. Paravertebral block of 5th, 6th, 7th, and 8th left intercostal nerves. *General*: Intratracheal gas and oxygen (Dr. T. A. B. Harris).

Technique.—The abdomen was opened through a midline incision from the xiphisternum to the umbilicus. The stomach was explored with the hand, and a hard growth was felt at the cardia. The mass was about the size of a tangerine, smooth on its outer surface, and sharply limited above and at its edges (*Fig.* 11). There were no hard glands on the lesser curvature or in the gastro-splenic omentum, no plaques in the peritoneum, and no nodules in the liver, and, as far as could be felt through the diaphragm, there was no extension upwards beside the œsophagus.

The greater curvature of the stomach was mobilized by dividing between ligatures all the omental branches of the gastro-epiploic arch and all the vasa brevia, from a point two inches to the left of the pylorus up to the diaphragm (*Fig.* 12). The stomach was then turned upwards, the peritoneum over the upper border of the pancreas incised, and the left gastric artery divided between ligatures at its origin from the cœliac axis. The vessels on the lesser curvature were tied and divided three inches to the left of the pylorus. From this point the lesser omentum was cut close to the liver as far as the diaphragm. The stomach was turned up once more, and the peritoneum, fatty and lymphatic tissue dissected upwards from the point of ligature of the left gastric artery, leaving the diaphragmatic pillars and hiatus bare (*Fig.* 13): this dissection was continued at the sides and in front of the cardia till the œsophagus lay free in its opening, and all the loose tissue surrounding the cardia and upper end of the stomach had been mobilized with it.

The stomach was now divided by an L-shaped cut into two portions—a proximal one including most of the fundus and half of the lesser curve; and a distal one the shape of a pistol upside down, the handle represented by the pars pylorica, the barrel by a long tube of greater curvature carrying the gastro-epiploic arch (*Fig.* 14). This division was facilitated by the Friedrich-Petz clamp. The clamp was first applied from the fundus in a line parallel to and 2 in. from the greater curve, and the crushed strip was cut between two rows of clips

with a knife. The clamp was then re-applied in the apex of this cut, continuing its line for a further 3 in., and once again from the lesser curve to meet the end of the second row of clips

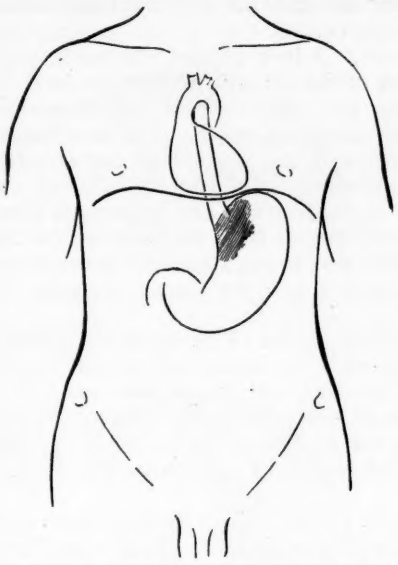

FIG. 11.—Position and relative size of the growth.

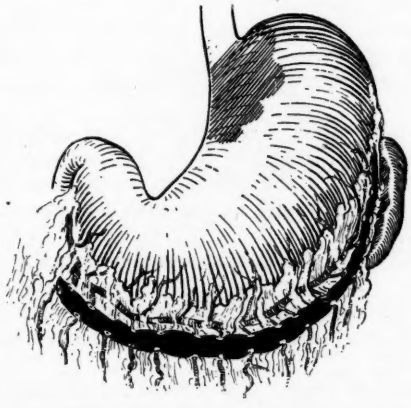

FIG. 12.—The omental branches of the gastro-epiploic arch have been divided, mobilizing the greater curvature of the stomach, with its blood-supply.

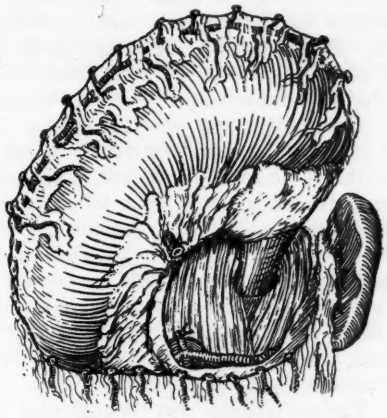

FIG. 13.—The left gastric artery has been ligatured at its origin, and a little fatty and lymphatic tissue dissected off the diaphragm from this point to the œsophageal opening.

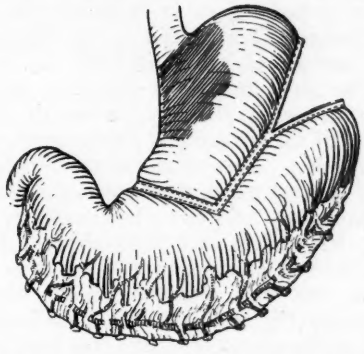

FIG. 14.—The stomach is being divided into two portions with the aid of the Friedrich-Petz sewing clamp.

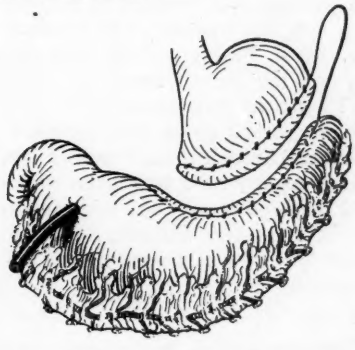

FIG. 15.—The two portions of the stomach have been separated and oversewn, and are temporarily attached by a silk thread.

(*Fig.* 14). A cut with the knife then separated the two portions. The long line of clips on each portion was then infolded with a continuous Lembert suture, the upper portion roughly, to reduce its size and prevent leakage, the lower part with considerable care. The greater

curvature tunnel thus formed was temporarily attached to the proximal closed part of the stomach by a 3-in. length of stout silk doubled (*Fig.* 15). A No. 12 de Pezzer catheter was inserted through a small independent incision in the anterior wall of the stomach 2½ in. proximal to the pylorus, and secured by a double invaginating purse-string suture. The tube, clamped with Spencer Wells forceps, was dropped back into the abdomen, and the incision was closed with three stitches of stout silkworm gut passed through all layers of the abdominal wall.

The patient was now turned on to his right side. A long incision was made over the 7th intercostal space, turning up at the outer border of the erector spinæ to the level of the 4th rib. One inch of the 5th, 6th, and 7th ribs near the angle was resected subperiosteally. The chest was opened by a long incision in the 7th intercostal space. The œsophagus was isolated halfway between the aortic arch and its lower end, and a length of rubber tube was passed round it. Aided by traction on this tube, the lower end was freed by knife and scissors dissection, till a finger could be passed all round it at the hiatus. The diaphragm, lifted up by a finger passed alongside the œsophagus, was cut outwards from the hiatus in the line of its fibres for about 2 in. (*Fig.* 16). By traction on the œsophagus, the closed proximal pouch of the stomach was pulled through the enlarged opening into the thorax, bringing with it the attached greater curvature tunnel (*Fig.* 17).

The œsophagus was then divided between crushing clamps 1½ in. above the cardia, and the portion of stomach containing the growth removed. The upper end of the œsophagus was surrounded with flavine packs, the clamp was removed, and the cut end was held open with forceps. A rubber tube of ⅜-in. external diameter, expanded 1½ in. from its termination to form a flange ⅞ in. in diameter, was passed into the œsophagus till the flange lay half an inch inside. The cut end of the œsophagus was tied round the tube below the flange with three ligatures of No. 4 silk (*Fig.* 18).

The tip of the greater curvature tunnel was cut off. A pair of forceps was passed through a stab incision in the anterior wall of this tunnel, about 5 in. from its tip, and used to seize the end of the œsophageal rubber tube, and pull it down into the tunnel and out through the stab incision. The cut end of the œsophagus was sutured to that of the tunnel by three catgut stitches passed under the œsophageal silk ligature and through all coats of the stomach. The œsophagus was held down by traction on the rubber tube while the stomach tunnel was pulled up by forceps on each side, about 1 in. down from its free end. The invagination thus produced was secured by two or three stitches from stomach to œsophageal wall, and the process was then repeated, another inch of stomach tunnel being drawn up round the œsophagus (*Fig.* 19). At the second invagination the upper edge of the infolded tunnel reached nearly to the aortic arch, and was fixed at this level by interrupted stitches to the pleura, and one or two uniting stomach to œsophagus.

The left phrenic nerve was crushed where it lay on the pericardium. The incision in the diaphragm was sutured to reduce the opening to the diameter of the greater curvature tunnel, and the opening was stitched to this tunnel above the emerging œsophageal tube. A No. 12 de Pezzer catheter was passed through a stab wound in the 10th left intercostal space, and the chest wound was closed completely.

The patient was turned over on to his back, and the abdominal incision re-opened. The subdiaphragmatic space was carefully mopped dry. The œsophageal tube was brought to the surface through a stab wound just below the left costal margin in the mid-axillary line. The gastrostomy tube was taken through a separate small incision in the right rectus muscle, and the incision was closed without drainage (*Fig.* 20).

POST-OPERATIVE HISTORY.—On his return from the theatre the patient's condition was satisfactory; he was a good colour and the pulse was 100 and of fair volume. He was given a transfusion of 16 oz. of blood. An intravenous drip infusion of 5 per cent glucose in saline was given, for the first four days at the rate of 4 pints a day, and for the last two at 6 pints.

Intermittent negative pressure was applied every three hours to the de Pezzer catheter draining the left pleura, the tube being clamped during the remainder of the day. On the first occasion about 4 oz. of blood were drawn off, but subsequently only small amounts of slightly stained pleural fluid were obtained. The œsophageal tube was connected by rubber tubing to a jar with a fluid trap: altogether a few ounces of slightly stained saliva drained from the œsophagus. Feeding through the gastrostomy tube was started seventy-eight hours after operation.

On the second day his general condition was excellent. The temperature was 98°, the pulse 70, respiration 26. Air entry could be made out in the left upper lobe; a few râles could be heard at the right base. On the third day he became cyanosed and restless rather suddenly, but after inhaling oxygen and coughing up a considerable amount of purulent mucus, he improved, and the general condition appeared satisfactory. On the evening of the fourth day he began to cough again, bringing up thick purulent phlegm. He became a little cyanosed, and spent a restless night. The cough and restlessness increased next day,

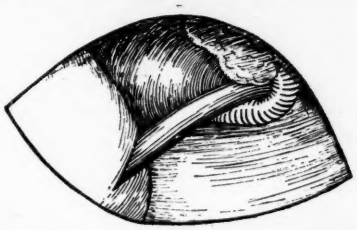

FIG. 16.—The thorax has been opened, the œsophagus freed from its bed, and the œsophageal opening in the diaphragm enlarged by incision.

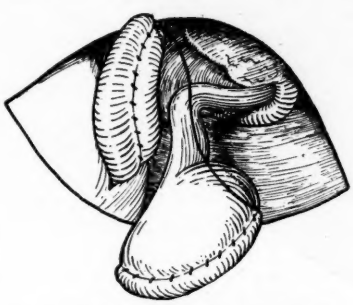

FIG. 17.—The cardiac portion of the stomach, and the 'greater curvature tunnel' have been drawn into the thorax.

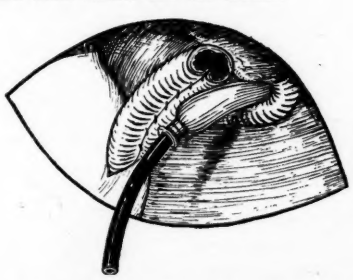

FIG. 18.—The cardiac portion of the stomach and lowest 1½ in. of œsophagus have been removed, and the proximal œsophagus has been tied round a flanged rubber tube. The tip of the gastric tunnel has been cut off.

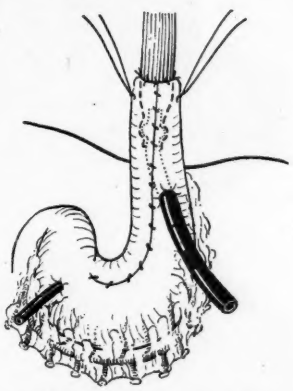

FIG. 19.—The œsophagus with its contained rubber tube is being 'intussuscepted' into the gastric tunnel.

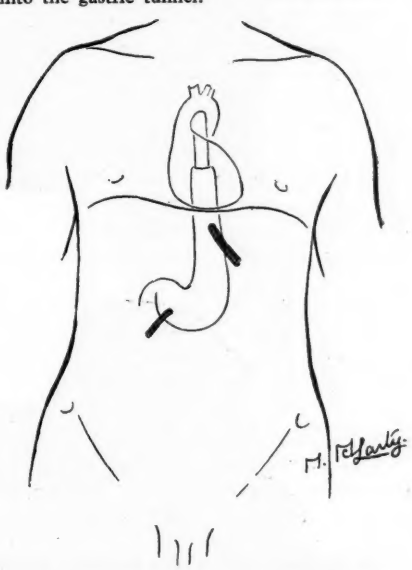

FIG. 20.—The final arrangement of the anastomosis.

and his condition deteriorated rapidly. Death occurred on the sixth day, 150 hours after the operation.

POST-MORTEM EXAMINATION.—The gastro-œsophageal anastomosis looked healthy. The suture line was well sealed off, and there had been no leakage, either at the junction, or along the 'seam' of the greater curvature tunnel. The sutured diaphragmatic opening was sound. Three ounces of clear fluid were found in the left pleural cavity, but there was no infection in pleura, mediastinum, or peritoneum. The lower lobe of the left lung was collapsed. The base of the right lung was congested, the bronchi contained much muco-pus, and patchy areas of consolidation were found throughout. The mediastinum was removed *en bloc* for examination (*Figs.* 21–23).

A B

FIG. 21.—The tissue excised, (A) as removed, (B) opened up.

FIG. 22.—The post-mortem specimen, showing the anastomosis, the œsophageal tube, and the gastrostomy tube. The lower plane of the section is 1 in. beyond the pylorus. View from in front.

FIG. 23.—Showing the specimen viewed from the right.

COMMENTARY

It is unnecessary in a case report of this kind to review the history or literature of œsophageal resection. Two points require discussion: why the method described was adopted; and why it failed.

In common with many who started surgical practice shortly after the war, I was fired by Torek's magnificent case, followed shortly by that of Eggers, to study the possibility of surgical attack on cancer of the œsophagus. Working as a registrar and demonstrator of anatomy, I had ample access to post-mortem and dissecting-room material, and was able to practise the various operations that had been performed or suggested, and to explore the technical difficulties and possible advantages of alternative methods.

For growths anywhere near the root of the lungs and aortic arch, it seemed necessary to extirpate the whole thoracic œsophagus by some such method as Torek had successfully employed, and if possible to re-connect the upper end to the stomach at a later date by an extrathoracic tube of skin. For those at the lower end of the œsophagus or the cardiac orifice, the right course was much less clear. Complete excision of the entire thoracic œsophagus together with the cardiac portion of the stomach would be a pathologically complete operation, but very much more severe than œsophagectomy for a higher growth, and probably too severe to succeed. In a mid-œsophageal growth the œsophagus may be divided at a safe distance below the lesion and its lower end crushed, ligatured, and invaginated; in one at the lower end, the cardiac portion of the stomach and all the surrounding fatty and lymphatic tissue in the sub-diaphragmatic space must be removed with the œsophagus. The left gastric and branches of the splenic artery must be tied, and a wide opening in the stomach must be sutured in two layers. An abdominal operation is added to the thoracic one. When this part of the operation has been completed, the lower end of the œsophagus carries a bulky mass consisting of the growth and its surroundings, a mass that cannot be pulled under the aortic arch and through the superior mediastinum into the neck. If a resection of the Torek type is contemplated, the œsophagus must be divided again above the growth, closed, and then freed below the aortic arch and pulled up into the neck.

For these reasons it appeared that resection of the lower part only of the œsophagus would eventually prove to be the correct operation for low œsophageal and cardiac growths. The method whereby the œsophagus could be joined to the stomach then arose. Hedblom had successfully resected a cardiac growth, bringing the lower end of the œsophagus and the fundus of the stomach to the surface on the left side of the chest after a preliminary thoracoplasty. His case died within a few months from recurrence, but his method seemed to circumvent the dangers of distal œsophagectomy. If the œsophagus could safely be brought to the surface after adequate resection of its lower end, the operation would be divided into two stages, and the junction of œsophagus to stomach could be done by a number of alternative methods. Practice on the cadaver suggested that this step was technically possible, but surgically unsound. After section a sufficient distance above the diaphragm, the upper end of the divided œsophagus can be brought to the surface by freeing it well up to the aortic arch, and by bringing the chest wall in to meet it by wide rib resection as first suggested by Zaaijer; but it is angulated,

and its blood-supply jeopardized by stripping and tension, so that it would probably either slough or tear out the stitches that hold its fragile wall to the skin, and retract again into the thorax.

It seemed therefore that resection of the lower part of the œsophagus implied an immediate reconstruction of the food passage. Attempts to perform end-to-end anastomosis after resection of even short portions, lead almost inevitably to the conclusion that the œsophagus is unsuturable material. In theory tissues of every type can be sutured, but in practice the stitches must get a firm hold on fibrous tissue or they cut out under tension. The œsophagus is notably lacking in a firm fibrous coat; the mucous membrane lies on a layer of alveolar tissue, and round this are muscle bundles whose loose arrangement is in marked contrast to that in any other portion of the alimentary canal. Suture is of course possible; but if the suture line is under any tension it gives way. A two-layer anastomosis, such as would be performed in stomach or intestine, is almost impossible, for infolding stitches in the outer coats tear as soon as they are tied. End-to-end suture in the thorax is in addition difficult because of the depth and rigid margins of the wound, and because access to the deep aspect of the suture line demands rotation of the tube.

The lower end of the œsophagus lies beneath the diaphragm, and by traction on the stomach while the peritoneal and fibrous layers round the cardiac opening are divided, at least two inches of thoracic œsophagus can be brought in addition into the abdomen. It comes down like a rubber tube, and, like rubber, it goes up again as soon as the pull is relaxed. Complete gastrectomy and suture of the jejunum or even the duodenum to the œsophagus is therefore possible by the abdominal approach, and has often been performed; but the unpublished fatalities greatly outnumber the successes, and the cause of failure is always the same—leakage at the suture line. If gastrectomy is quasi-total, if a collar of stomach even $\frac{1}{2}$ in. deep can be left round the œsophagus, the anastomosis is comparatively easy and the risk is not great. But when the plane of section is truly œsophageal the stitches tend to tear out on their œsophageal side as soon as any strain is put on them; an anastomosis may be made, but the surgeon is profoundly dissatisfied with the suture line as a piece of needle work, and with the œsophagus as surgical material. If more than the minimal amount of œsophagus is resected, it is almost impossible, from below, to make a junction with the jejunum that will hold. It seemed to be essential, therefore, in the surgery of cardiac or lower œsophageal cancer, that, if any form of anastomosis was to be attempted after resection, it must be so arranged that the distal tube was brought to the œsophagus, and the suture line made where the œsophagus lay naturally after section, so that stitches were asked to do no more than approximate. This implied that any reconstruction of the lower end of the œsophagus must be done in the thorax.

The jejunum or the stomach may be brought up through the diaphragm for anastomosis. The jejunum is not implicated in the disease for which resection is necessary, and it is a tube of suitable diameter. A loop can be brought through an opening in the transverse mesocolon up to the œsophageal opening in the diaphragm, but it cannot be taken any higher without some tension. By isolation of its mesentery, a separated loop can be mobilized sufficiently to come two inches or more into the thorax, but its blood-supply is under some tension. The fundus of the stomach on the other hand lies immediately under the left

cupola of the diaphragm, above the level of the lower end of the œsophagus, and it can be brought well up into the thorax without any mobilization, and as far as the aortic arch after ligature of the left gastric artery and vasa brevia. It is natural, therefore, that the methods that have been suggested for intrathoracic reconstruction of the lower œsophagus have for the most part made use of the fundus of the stomach. The chief point against its use is that it may be involved in the growth, and in any case an adequate removal of the lymphatic areas subjacent to the growth must encroach upon it to some extent.

Two of the more obvious methods were practised repeatedly on the cadaver —the method of direct invagination by purse-string suture, and the trap-door method. Both have advantages and drawbacks. The 'ink-bottle' method (*Fig.* 24) requires no dissection and a minimum of sutures, and places the opening of the œsophagus well inside a tube formed by all the coats of the stomach; but once the cut end of the œsophagus has been sutured to the hole in the stomach the purse-string suture has to be passed all round it where it lies on the mediastinum, and the junction has to be invaginated, with no possible push or pull on the œsophagus to aid it. A first purse-string can be done; a second is very difficult; a third still more so. The trap-door method (*Fig.* 25) avoids all the difficulties of invagination and suture on the far side of the œsophagus, and places the opening inside the stomach cavity, above which the œsophageal wall lies buried between two raw surfaces, the submucous and the muscular coats: its risks lie in the structure of the fundus. In the body of the stomach the muscular coats are thick, the submucous layer is loose, and the outer coats can be freely separated from the mucous lining; in the fundus the whole stomach wall is thin and the layers adherent, so that the outer coats can hardly be separated without tearing, or sutured securely over the enclosed œsophagus. Fundus invagination appeared on technical grounds to be the most practicable way of restoring continuity after low œsophageal resection, but though several cases that presented themselves appeared suitable, exploration proved them otherwise, and the method was never used at operation.

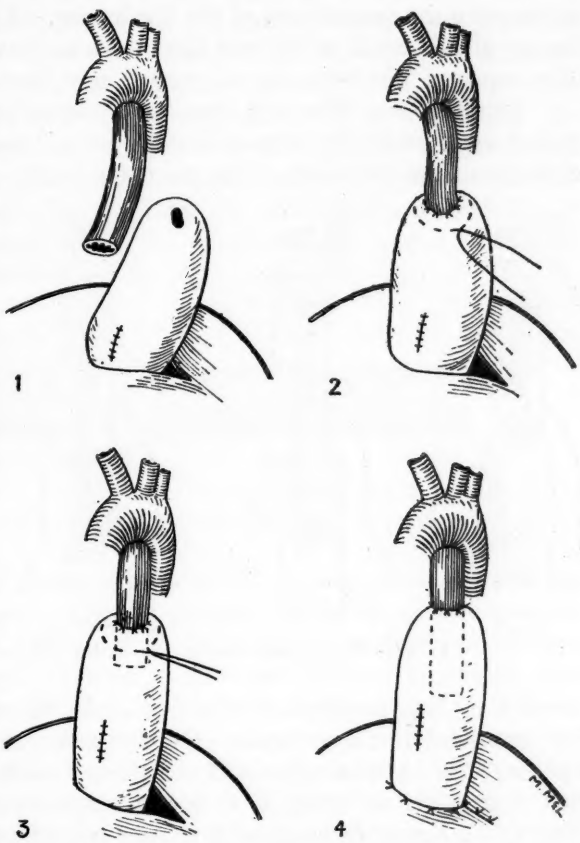

FIG. 24.—Œsophago-gastrostomy by fundus invagination.

Two years ago the problem of suture of the unsuturable presented itself in another form. A man of 50 had been explored elsewhere in 1934 for attacks of pain, vomiting, and jaundice. A mass was found in the head of the pancreas, obstructing the duodenum, and gastro-jejunostomy was performed, the gall-bladder being removed at the same time. The attacks increased in severity, he became deeply jaundiced, and lost 5 st. in weight. When I saw him in March, 1935, a diagnosis of carcinoma of the ampulla of Vater had been made by Sir Arthur Hurst on the coexistence of deep jaundice, duodenal obstruction, and large quantities of occult blood in the motions. At laparotomy the pancreas was found enlarged and hard throughout its length, and a large mass partly surrounding and completely obstructing the second part of the duodenum. The mass appeared to be cancerous, but no glands could be felt and there were no metastases in the liver or peritoneum. The common bile-duct was distended to a diameter of half an inch.

The duct was dissected free in its supraduodenal course, and this part was pulled upon while the retroduodenal portion was followed and cored out by blunt dissection from the mass. The duct was finally cut across, giving a free length of

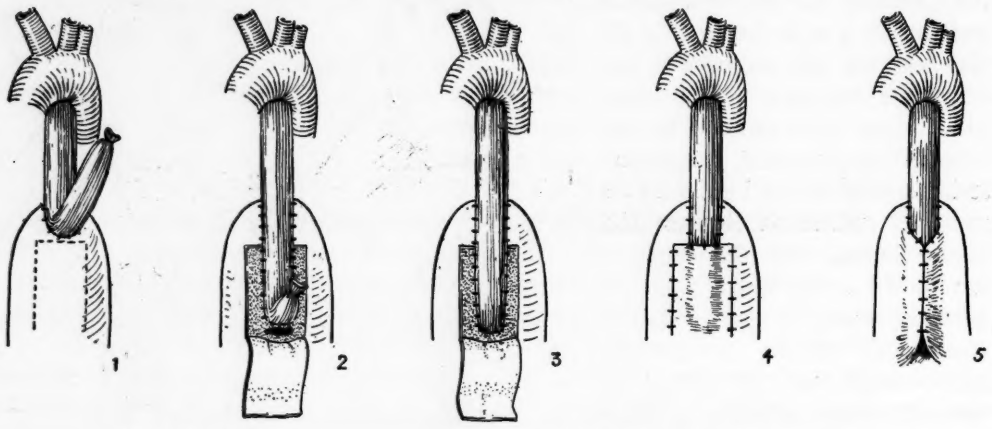

FIG. 25.—Œsophagogastrostomy by fundus trap-door (Herman Fischer's method).

about 2 in., the termination of which could be swung across to reach the stomach just proximal to the pylorus. The common bile-duct can be sutured to close an opening, but its thin walls will not stand suture under tension, and in this case it was impossible to bring it to the stomach without the stitches tearing out. A No. 12 de Pezzer catheter with the tip cut off was therefore passed into the duct, and a silk ligature tied firmly round duct and tube just behind the mushroom end. The duct could now be pulled by pulling on the catheter without any risk of tearing. Two holes were made in the stomach, one on the anterior wall $1\frac{1}{2}$ in. proximal to the pylorus, and one near the greater curve 3 in. away from the first. The tube was passed across the stomach cavity, through the first hole and out at the second, and, when pulled upon, drew the common duct well into the stomach and held it there. Two fine stitches were put through the edges of the hole and the outer coats of the common duct, and the gastric wall was then infolded round the duct by a continuous suture, after Witzel's method. The second hole was invaginated round the emerging tube by two purse-string sutures, and the tube brought to the surface through a stab incision in the abdominal wall. The removal of this tube

on the tenth day was not followed by any leakage. The patient made an excellent recovery, and is now well, so that the diagnosis of malignancy appears doubtful.

This case appeared to suggest a means to rob œsophageal suture of most of its dangers. Fresh experiments on the cadaver showed that an anastomosis by the method of fundus invagination could be done with ease and certainty with the help of a No. 30 French de Pezzer catheter. It was only necessary to pass the tube through a stab incision in the fundus and out again through one in the body of the stomach, to allow complete control of the œsophagus. Traction on this tube, while the stomach wall was pulled up with two tissue forceps and the purse-string suture was tightened, gave perfect invagination. The method was further improved by substituting a rubber tube with a mushroom flange in its course for the catheter. When a de Pezzer catheter was used, the terminal mushroom was pulled inside the grip of the first purse-string, and the second and third approximated the stomach wall round an empty œsophagus; if they were too tight they might narrow the lumen, if not tight enough they would not give secure contact between the surfaces. With the new type tube (*Fig.* 26) made by the Genito-Urinary Co., a straight portion lies in the œsophagus above the mushroom, holding it as a semi-rigid cylinder round which the stomach can be firmly apposed.

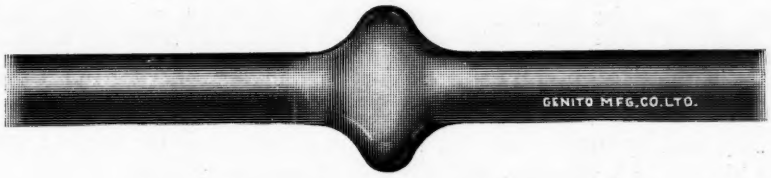

FIG. 26.—Flanged tube for œsophageal anastomosis.

In considering the case which is the subject of this communication, there was little reason to hope that resection would be possible, since all cardiac growths explored in the past had extended widely outside the coats of the stomach. When, however, the tumour proved to be scirrhous in type and limited in outline, with no palpable extensions beyond the stomach wall, it was disappointing to find the local spread too wide to allow the fundus to be used, as had been done in the practice operations. Since the patient had stated most emphatically that he would much rather die on the table than return to bed with his growth, it was necessary to think out an alternative method, and the greater curvature tunnel was improvised on the spot. No doubts, however, were felt about its technical soundness. The peculiar difficulties of large posterior gastric ulcers had on two previous occasions forced the use of a tube fashioned from the fundus and nourished only by a few of the upper vasa brevia, a flap that depended on a blood-supply far more precarious than that of the tunnel which it was now proposed to use, yet one that healed uneventfully in each case. The surgeon who has any considerable experience of gastric surgery is driven to adopt so many expedients, to perform so many atypical resections, that he inevitably comes to agree with Finney that "the stomach is a very viable organ". It is indeed remarkable that all its arteries may be ligatured, yet it bleeds copiously when cut; that its walls may be divided in any plane and anastomosed to any part of the small intestine at any angle, yet they never slough.

The greater curvature gastric tunnel which is here suggested as a method for œsophageal reconstruction has manifest advantages. It is well supplied with blood, it is mobile, and of a length far in excess of any that can conceivably be required; it employs part of the stomach wall that is well away from the zone of spread of an operable growth; its diameter does not demand any great enlargement of the œsophageal hiatus in the diaphragm, and it allows a method of suture that is amply secure, that puts no tension on the œsophagus, and that is almost immune from soiling by œsophageal contents.

The patient died, as far as could be judged on clinical grounds and ascertained by post-mortem examination, from pulmonary complications after an operation that was technically successful. Two circumstances possibly favoured the onset of these complications—the immobilization of the left diaphragm, and the intravenous administration of too large a volume of saline solution.

The phrenic nerve was crushed, not to help the excision, but to rest the suture line in the diaphragmatic opening. This step was certainly unnecessary, for a double row of interrupted sutures should be amply secure; and it was probably unwise, since it must have hindered re-expansion of a collapsed lung.

Saline-glucose was given intravenously to overcome the dehydration already present, and to supply fluids in the immediate post-operative period. In this case all the fluids required by the patient could probably have been given by the gastrostomy tube. The intravenous route is so convenient, so certain, and in most cases so apparently innocuous, that the risks of interfering with the balance of salts and colloids in the tissues, and in particular the dangers inherent in the routine use of salt solutions, are insufficiently appreciated. Coller and Madox have shown that, whereas healthy individuals can maintain a normal water balance when given 5 per cent glucose in a physiological solution of sodium chloride by the intravenous route, all the sick surgical patients investigated retained water under the same régime, and some developed definite œdema. Those given glucose in Ringer's solution retained water to a lesser extent. When the administration of salt solution was stopped, and glucose in distilled water was substituted, all the patients of this group lost the water they had previously retained, and established a normal balance. It appears, therefore, that unless sodium chloride is actually being lost by vomiting or diarrhœa, the parenteral administration of salt solution is not only unnecessary, but dangerous, carrying the risk of œdema.

SUMMARY

An attempt at intrathoracic reconstruction of the lower œsophagus is recorded.

A new method of anastomosis is described which avoids suture of the œsophageal wall and minimizes the risk of post-operative leakage.

THE PATHOLOGY AND TREATMENT OF RECURRENT DISLOCATION OF THE SHOULDER-JOINT

By A. S. BLUNDELL BANKART, London

Recurrent dislocation of the shoulder-joint is an uncommon condition, the real nature of which appears even now to be little understood. It may almost be said to be peculiar to athletes and epileptics—a rather curious association which, as I shall show, is not without aetiological significance. Most of the former class are powerful, healthy, athletic young men to whom the frequently recurring dislocation from trivial causes is a great and serious disability. In epileptics the dislocation sometimes recurs with every fit. The dislocation is nearly always anterior. I have only seen one case of posterior recurrent dislocation of the shoulder.

ALLEGED CAUSES

The condition has been attributed to abnormal laxity of the capsule and to weakness of the surrounding muscles. The abnormal laxity of the capsule is supposed to be due to stretching or imperfect healing of that structure after the reduction of an ordinary traumatic dislocation, and it has been thought that too early and too vigorous use of the arm may be the cause of the defect. Alternatively, or in addition to these factors, recurrent dislocation has been attributed to fracture of the glenoid cavity, fracture of the humeral tuberosities, deformity of the head of the humerus, and to contracture of some of the muscles around the joint.

It may be said at once that none of these alleged causes has been present in any of the 27 consecutive cases which form the basis of this communication. I have never seen recurrent dislocation associated with fracture of the glenoid cavity or with any other bony abnormality, and I would suggest that, if such an association occurs at all, it must be very rare indeed.

VARIOUS OPERATIONS

Five types of operations have been performed for the relief or cure of this disability :—

1. Operations designed to diminish the size of the capsule. These comprise various pleating or overlapping procedures, with or without incision or excision of a portion of the capsule.

2. Operations designed to give support to the capsule, particularly at its lowest part, where the dislocation is believed to take place during abduction of the arm. The most favoured of these operations is that of Clairmont and Erhlich, in which a strip of the deltoid muscle is transplanted in the form of a sling beneath the joint, and is supposed to contract and hold up the head of the humerus when the arm is abducted.

3. Operations designed to hold the head of the humerus in place by means of an artificial ligament constructed either from the tendon of the long head of the biceps (Nicola) or from a free transplant of tendon or fascia (Henderson).

4. Operations which aim at the construction of a bony block in front of the head of the humerus.

5. The operation described below for the repair of the essential anatomical defect.

All these operations, with the exception of the last, are based upon erroneous ideas of the pathology of recurrent dislocation of the shoulder, or they ignore the pathology and attempt to deal empirically with the resulting clinical condition. In the first place, the capsule in these cases is not unduly lax. The capsule of the shoulder-joint is normally a lax structure, but more than one surgeon has commented on the difficulty of raising a satisfactory fold when doing a plication operation for recurrent dislocation. Secondly, the muscles are not weak. There may be some wasting of the muscles after this, as after any other, injury to the shoulder-joint, but the powerful musculature that is usually exhibited by these patients is a sufficient commentary on this point. Thirdly, the joint does not need support below, for it is not here that the dislocation takes place. And lastly, the unnatural tethering of the head of the humerus by an artificial ligament, and its obstruction by means of an abnormal excrescence of bone, are equally crude and irrational methods of dealing with a straightforward anatomical defect.

It must be admitted that these operations have sometimes been successful in preventing recurrence of the dislocation. Indeed, it would seem that almost anything done to the shoulder may have this effect. It has even been claimed that simple manipulation will cure recurrent dislocation (Barker), though how this procedure can bring about the closure of a gross and demonstrable anatomical defect it is impossible to imagine. It is probable that most of these operations produce this effect by limiting the normal movements of the shoulder-joint, while the patient contributes to the result by avoiding any movement which is liable to produce the dislocation.

THE MECHANISM AND CAUSE OF RECURRENT DISLOCATION

It has been too readily assumed that recurrent dislocation is an unfortunate sequel of ordinary traumatic dislocation of the shoulder-joint; and I have known medical men reproach themselves quite unnecessarily for their treatment of the original injury. Recurrent dislocation has nothing whatever to do with ordinary traumatic dislocation. It is from the first an entirely different injury, and it is produced in an entirely different manner.

Ordinary dislocation of the shoulder is the commonest of all dislocations of the joints. It is caused by a fall on the abducted arm. In extreme abduction the neck of the humerus impacts against the acromion process, and then by leverage the head is forced through the lowest and weakest part of the capsule between the subscapularis and triceps muscles. When such a dislocation is reduced, the rent in the capsule heals rapidly and soundly, and the dislocation never recurs.

But the dislocation which afterwards becomes recurrent is caused, not by a fall on the abducted arm, but by a fall either directly on the back of the shoulder

or on the elbow which is directed backwards and slightly, if at all, outwards. The head of the humerus is forced out of the joint, not by leverage, but by a direct drive from behind forwards. In its passage forwards the head shears off the fibrous or fibrocartilaginous glenoid ligament from its attachment to the bone. The detachment occurs over practically the whole of the anterior half of the glenoid margin. The reason why the dislocation recurs after reduction is that, whereas a rent in the fibrous capsule heals readily and soundly, there is no tendency whatever for the detached glenoid ligament to re-attach itself to the bone. The defect in the joint is therefore permanent, and the head of the humerus is free to move forwards over the anterior margin of the glenoid cavity on the slightest provocation.

In quite a number of cases the original injury is stated to have occurred at football, and it may be noted that in this game, at least, a player is seldom sent sprawling with his arms out, but, when he falls or is thrown to the ground, it is usually in some moment of strenuous action, when his muscles are tense and his arms are more or less close to his sides. Usually he is too preoccupied to make much attempt to save himself, and in falling backwards he is likely to strike either the back of the shoulder or the point of the elbow which is directed backwards. The epileptic, too, falls with his muscles tensely contracted, and he, of course, makes no effort to save himself. Frequently his arms are drawn backwards and little, if at all, abducted, so that if he falls backwards he is likely to strike either the back of the shoulder or the point of the elbow. Thus, both athletes and epileptics are liable to sustain dislocation of the shoulder-joint by direct violence rather than by indirect force or leverage.

I have now exposed the typical lesion of recurrent dislocation—namely, detachment of the glenoid ligament from the anterior margin of the glenoid cavity—at operation in 27 consecutive cases. It is a constant, straightforward, uncomplicated anatomical condition, which can be observed at any time by any competent surgeon who cares to expose the anterior margin of the glenoid cavity in any typical case of recurrent dislocation of the shoulder-joint. It is easy then to demonstrate the mechanism of the recurrent dislocation, for on taking hold of the arm and pushing its upper end forwards, the head of the humerus can be made to pass freely over the anterior margin of the glenoid cavity. No one who has ever seen this typical lesion exposed at operation could possibly doubt that the only rational treatment is to reattach the glenoid ligament (or the capsule) to the bone from which it has been torn.

It may be noted that the glenoid margin cannot be exposed by the anterior incision ordinarily employed for arthrotomy and plastic operations on the shoulder-joint, and no doubt this is the reason why the anatomy of recurrent dislocation has not been generally recognized. The operation here described has been planned to expose completely the anterior aspect of the shoulder-joint, and to deal directly with this typical injury.

AUTHOR'S OPERATION TO REPAIR ESSENTIAL ANATOMICAL DEFECT

Position of Patient.—The patient lies on the operating table with a small pillow or sandbag between the shoulder-blades, and with the arm by his side. A sandbag should be placed beneath the elbow on the affected side so as to support the shaft of the humerus in a horizontal plane parallel to the table.

Technique.—

1. Make an incision about 5 in. long from the lower border of the clavicle immediately above the coracoid process in a direction downwards and outwards along the anterior border of the deltoid muscle (*Fig.* 27).

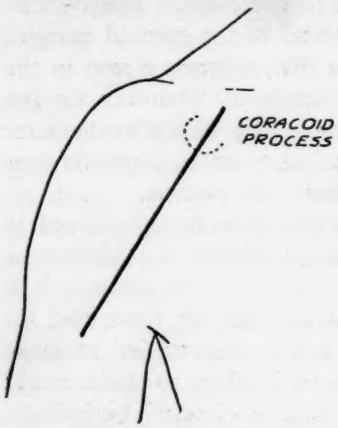

FIG. 27.—The incision.

2. Find the cephalic vein, which is the guide to the interval between the deltoid and the pectoralis major, and separate these two muscles throughout the whole length of the wound. The cephalic vein should be drawn inwards with the pectoralis major. A branch of the acromio-thoracic artery will be divided in the upper angle of the wound.

3. Hold the wound open with retractors and define the coracoid process and the three muscles attached to it, viz., the short head of the biceps, coracobrachialis, and pectoralis minor (*Fig.* 28).

4. With a sharp thin-bladed osteotome divide the coracoid process from above downwards about half an inch behind its free extremity, and pull the detached portion downwards with the three muscles attached to it.

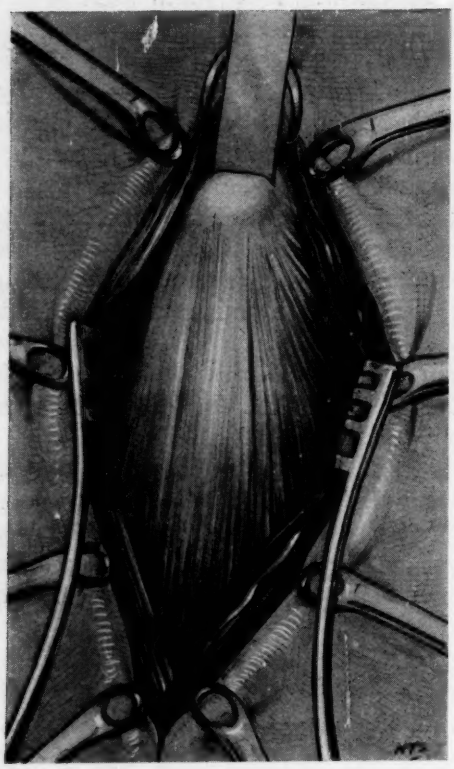

FIG. 28.—The deltoid and the pectoralis major muscles have been separated, showing the coracoid process and the three muscles attached to it. An osteotome has been applied to the upper surface of the coracoid process.

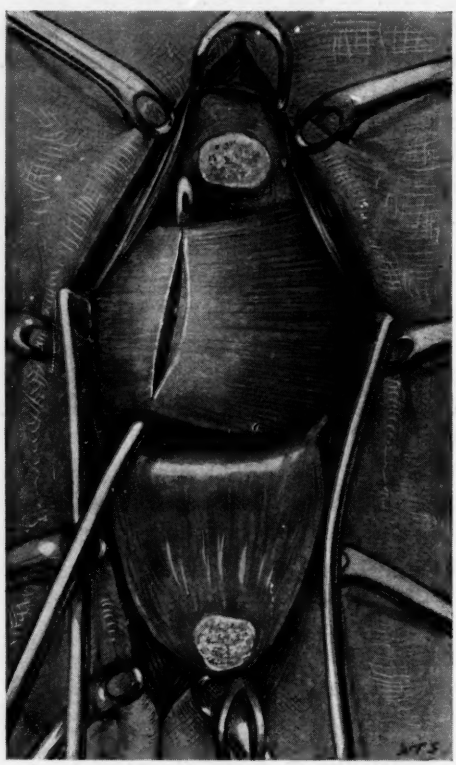

FIG. 29.—The coracoid process has been divided and the detached portion has been drawn downwards with the muscles attached to it. The tendon of the subscapularis is seen with an aneurysm needle passed beneath it. The tendon has been partially divided.

5. Rotate the humerus outwards so as to bring the subscapularis muscle into view. Pass an aneurysm needle under the tendon of the subscapularis, and divide the tendon near its insertion into the lesser tuberosity of the humerus (*Fig.* 29). Retract the subscapularis inwards.

6. Inspect the front of the shoulder-joint. In some cases there is a wide opening into the joint, and the glenoid ligament is found lying loose, either on the head of the humerus or over the margin of the glenoid cavity. In this case fix the free edge of the capsule to the glenoid margin, as described below. If the capsule appears to be intact, incise it over the glenoid margin, raise the narrow portion on the inner side of the incision, and proceed to fix the outer cut edge to the glenoid margin. This edge may include more or less of the glenoid ligament which remains attached to the capsule. In every case the anterior margin of the glenoid cavity

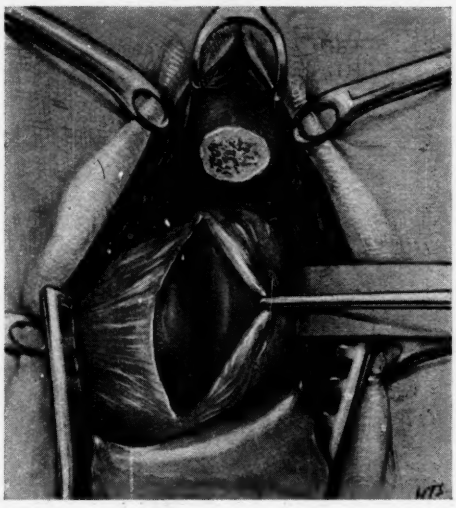

FIG. 30.—The tendon of the subscapularis has been divided and the muscle has been retracted inwards. A transverse opening is seen in the capsule of the joint, the outer edge of which lies on the head of the humerus, while the inner edge, which includes the glenoid ligament, has been raised by a hook from the anterior margin of the glenoid cavity. Note that the glenoid margin is smooth and rounded.

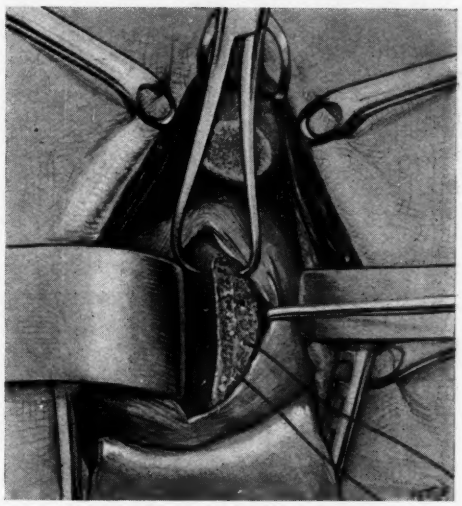

FIG. 31.—A thin shaving of bone has been raised from the anterior margin of the glenoid cavity and the neck of the scapula. Three holes have been made in the glenoid margin, and a pair of vulsellum forceps is seen in the act of making a fourth hole. A suture has been passed through the two holes in the lower half of the glenoid margin, and the two ends of this suture are seen emerging from the raw surface on the front of the neck of the scapula.

will be found to be smooth, rounded, and free of any attachments, and a blunt instrument can be passed freely inwards over the bare bone on the front of the neck of the scapula (*Fig.* 30).

7. Apply a broad chisel to the glenoid margin and raise a thin shaving of bone from the front of the neck of the scapula. If the shaving of bone remains attached to the scapula, preserve it; otherwise, remove it.

8. Draw the head of the humerus away from the glenoid cavity with a sharp hook or a special retractor.

9. Apply a pair of sharp-pointed vulsellum forceps to the anterior margin of the glenoid cavity. Take a good bite and gently work the sharp points through the bone. Do not be rough, or the forceps will tear out through the bone. In this way make two pairs of holes leading from the raw surface on the front of the neck of the scapula to just inside the glenoid cavity.

10. With a small curved needle pass a silkworm gut suture through the lowermost hole from the raw surface into the joint and then back through the next hole to the raw surface again. In the same way pass another suture through the second pair of holes (*Fig.* 31).

11. Thread the four ends of these two sutures on needles and pass them through corresponding points near the free edge of the capsule.

12. Press the edge of the capsule down on to the raw surface of bone, and tie each suture firmly over it with forceps. Cut the ends of the sutures short (*Fig.* 32).

13. If the shaving of bone has been preserved, replace it over the suture line and fix it down with a catgut stitch.

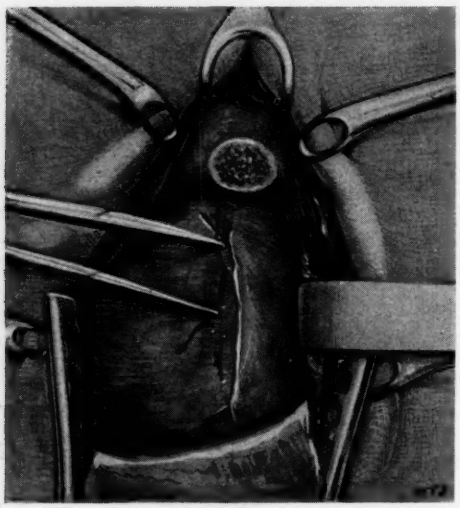

FIG. 32.—The free edge of the capsule has been drawn inwards and placed on the raw surface of bone in front of the glenoid margin and neck of the scapula. The two sutures have been passed through the edge of the capsule. The lower suture has been tied, and is shown with its ends cut short. The upper suture is being tied with two pairs of forceps.

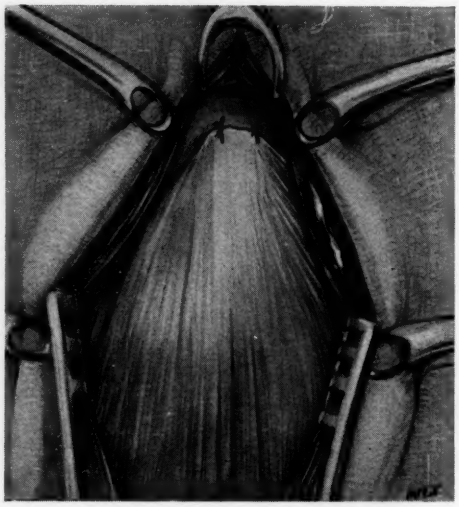

FIG. 33.—The subscapularis tendon has been sutured with catgut. The detached portion of the coracoid process has been replaced, and is shown held in place by two sutures of silkworm gut.

14. Suture the divided subscapularis tendon with catgut.

15. Replace the tip of the coracoid process and fix it in place with one or two silkworm gut sutures passed either through the bone or through the tendinous insertion of the muscles (*Fig.* 33).

16. Unite the deep fascia with a continuous catgut suture, and close the skin with a subcuticular stitch.

17. Apply dressings, and bandage the arm to the side with the elbow well forward.

18. Remove the subcuticular stitch on the tenth day. Keep the arm bandaged to the side for a month. Then begin active movements. Full movements should be regained in about a month. The dislocation does not recur.

SUMMARY AND CONCLUSIONS

Attention is directed to the pathological anatomy of recurrent dislocation of the shoulder-joint.

The difference between recurrent dislocation and ordinary dislocation of the shoulder is pointed out.

Recurrent dislocation is due to a wide detachment of the glenoid ligament from the anterior margin of the glenoid cavity. This anatomical defect is quite constant, and can be demonstrated in every typical case of recurrent dislocation of the shoulder.

An operation is described for the repair of this defect. This operation practically restores the shoulder-joint to its normal anatomical state, and it invariably prevents recurrence of the dislocation.

These statements are based upon an operative experience of 27 consecutive cases of recurrent dislocation of the shoulder-joint, in every one of which the typical injury was demonstrated. All these cases recovered full movements of the joint, and in no case has there been any recurrence of the dislocation.

A brief account of the pathology and treatment of this condition was first published in the *British Medical Journal* on December 15, 1923.

PRIMARY ACTINOMYCOSIS OF THE BREAST

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ACTINOMYCOSIS of the breast is so infrequent a lesion and its pathology so little understood that any additional information on the subject is worthy of careful attention. The following case, therefore, merits record.

CASE REPORT

Mrs. B. C., Bengali, aged 35 and quadriparous, was admitted to the surgical female wards of the Calcutta Medical College Hospitals under one of us (P. N. R.), for multiple sinuses in the right breast of nearly one year's duration.

HISTORY OF PRESENT ILLNESS.—About a year ago, when she was five months pregnant, she suffered from an abscess in the right breast, which opened at a point below the nipple with a profuse discharge of pus. She was, after a time, operated upon in her native town because the tracks refused to close. After the premature birth of the child at the seventh month, the same breast again became swollen and painful. A few weeks later it formed three discharging sinuses.

HISTORY OF PAST ILLNESS.—The patient suffered from recurrent attacks of mastitis in the right breast during each period of lactation or puerperium. There was no history of syphilis or of other miscarriage or abortion.

DURATION OF LACTATION.—The patient was in the habit of nursing each child for a period of twelve months or more. Prior to her admission into the hospital, she had two children at her breasts. One was about ten months old and the other nearly two years.

ON EXAMINATION.—The left breast was found to be much bigger than the right one, tender and engorged with milk. The right breast was deformed and much reduced in size. The nipple was retracted and eczematous; the areola was fissured and markedly pigmented. There were three linear scars in the inferior quadrants and several sinuses with a thin purulent discharge. A few drops of milk could be expressed manually from the nipple. The axillary lymphatic glands were enlarged and readily palpable, but there was no induration. There was nothing abnormal detected in the lungs or the chest, either clinically or by radiography. The Wassermann reaction was negative. The differential blood-count was as follows:—

White blood-corpuscles ..	3500 per c.c.
Polymorphs	62 per cent
Small mononuclears ..	32 per cent
Large mononuclears ..	0 per cent
Eosinophils	6 per cent

TREATMENT.—Stoppage of milk was soon effected by means of firm pressure bandage, limitation of fluid intake, and injection of camphor in ether. Later, the breast pump was used in order to induce passive hyperæmia. The examination of the material thus obtained proved to be negative. Ultimately, a local amputation was performed. A circular incision with a radius of two inches was made round the nipple, undercutting the skin and the subcutaneous tissues. The breast was adherent at places to the pectoral fascia and muscles, which were carefully resected. The wound healed up completely, and the patient was discharged from the hospital cured. During the convalescence she was given 40 gr. of potassium iodide daily for a period of two weeks.

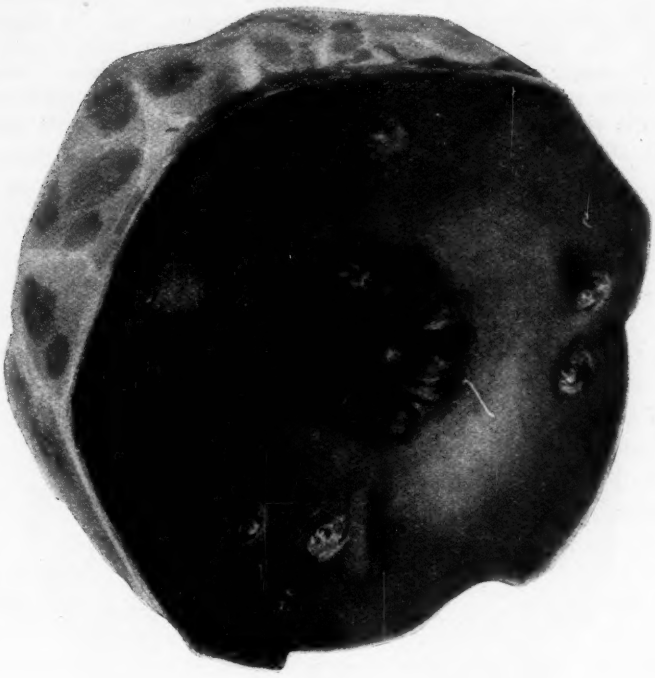

FIG. 34.—Showing the appearance of the breast after removal. Note the multiple sinuses, retracted nipple, and fissured areola. The eczematous condition of the nipple was much improved after local treatment.

FIG. 35.—Showing the 'drusen' with a central mass of necrotic material in which there are typical filaments, at the periphery of which club-like bodies can be seen with radial arrangement; surrounding this layer there is a mass of pus cells, outside of which are mononuclear cells and fibrous tissue.

EXAMINATION OF THE SPECIMEN.—The breast showed considerable atrophy and deformity. There were multiple sinuses scattered throughout, and the nipple was retracted and eczematous. The deep surface presented some adhesions both to the pectoral fascia and the pectoralis major muscle. But for the sinuses, the appearance was suggestive of Paget's disease of the nipple or of scirrhous carcinoma. On section, there was considerable fibrosis around the sinus tracks, but marked degenerative changes were also evident. No definite 'sulphur granules' were detected (*Fig.* 34).

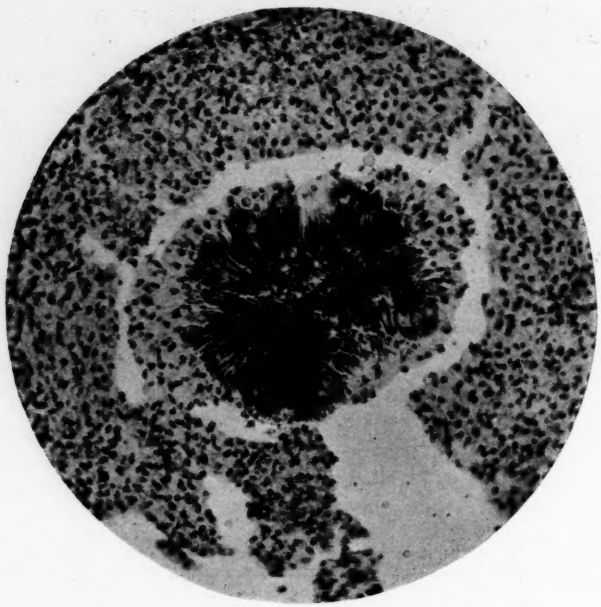

FIG. 36.—The same section as *Fig.* 35, under high power.

Microscopic Appearances.—The condition was readily recognized after histological examination of the biopsy material. The typical appearance of the actinomycotic 'drusen' cannot be mistaken (*Figs.* 35, 36).

It is regretted that no bacteriological investigations could be carried out. The examination of the patient's children for carious teeth or other infective lesions would have completed the bacteriological investigations. But, unfortunately, it was not possible to do this, as they could not be brought down to Calcutta from the country.

ANOTHER UNPUBLISHED CASE

We are indebted for particulars of the following interesting case to Dr. M. N. De, Professor of Clinical Medicine, and Dr. K. D. Chatterjee, Curator of the Pathological Museum. The pathological data were briefly recorded in a recent publication,[1] but the clinical notes were not given.

The patient, a Bengali female, aged 35 and multiparous, was admitted into the Lady Dufferin Hospital, Calcutta, for a suspected scirrhous carcinoma of the right breast. The condition was said to have been present for nearly eight years. She had one previous operation on the same breast for a suspected malignant growth, but a recurrence of the condition was noticed within a few months. The whole breast was riddled with sinuses and there were many fibrous cicatrices, producing a deformed and puckered appearance. The nipple, however, was not retracted, but the axillary lymph-nodes were found to be enlarged and palpable.

The breast was removed by a radical operation.

PATHOLOGICAL FINDINGS.—Some 'sulphur grains' were obtained from the depth of the sinuses. Microscopic examination showed the structure of chronic granulomatous tissue, with here and there the typical astral arrangment of fungal filaments.

COMMENTARY

Actinomycosis of the breast may be secondary to that in the lung and pleura, but appears to be very rare. Instances of primary actinomycosis have been recorded from time to time, but these are rarer still. Two cases described by Sehrt and Risel are quoted by Kaufmann.[2] In contemporary Italian literature similar cases have been described by Lazzarini[3] and Polichetti.[4] In another paper Zaffagnini and Gamberini[5] have emphasized the difficulty of diagnosis. Even when the ulcerative stage has been reached there is nothing characteristic to exclude other mammary affections. De and Chatterjee's case[1] was mistaken for a scirrhous carcinoma. The true ray fungus disease in man and cattle is caused by the *Actinomyces bovis* of Wolff and Israel. It may be of interest to note that the so-called actinomycosis of the udder in cattle appears to be invariably due to staphylococcal infection.[6] Actinomycosis is not infrequent in swine, in which the udder may be attacked.

The differential diagnosis in the present case lay between: (1) Tuberculous mastitis; (2) Chronic infective mastitis with sinuses; (3) Scirrhous carcinoma or Paget's disease of the nipple; (4) Osteomyelitis of the underlying ribs; (5) Gumma; and (6) Actinomycosis. The possibility of a gumma was eliminated by the clinical characters, negative Wassermann reaction, and absence of other stigmata, and of any disease of the underlying ribs by radiography. The presence of a carcinoma could not be negatived on clinical grounds, but the eczematous condition of the nipple was greatly improved by local treatment. The provisional diagnosis was therefore made of tuberculous mastitis. The possibility of actinomycosis was kept in mind, although no 'sulphur granules' were obtained from the purulent discharge.

Actinomycosis exhibits an extraordinary tendency to extend into healthy tissues, leaving no obvious trace of the disease at the site of entry. In the case of thoracic and abdominal lesions, there is a tendency towards metastasis by the blood-stream. *Actinomyces bovis* appears to be a strict parasite, and has never been found outside the animal body. Naeslund[7] is of opinion that the organism is a normal inhabitant of the human mouth, while the aerobic types merely gain access to the mouth through chance contamination of food. This view appears to be supported by the observations of Lord and Trevett.[8] The predisposing factors to infection are, however, not quite clear. The presence of suitable necrotic foci appears to be necessary for the development of the organism under anaerobic conditions. It has been isolated from the contents of carious dental cavities and tonsillar crypts. The organism is sometimes contained in the tartar of teeth, which on being detached may be transmitted to distant parts of the body, setting up pathological lesions.

There is one interesting feature in the clinical history of the present case. In India, prolonged lactation is not an uncommon practice. It is further encouraged by the popular belief that prolonged lactation acts as a deterrent against pregnancy. Children up to the age of two or three years are therefore often encouraged to suckle. The case under review might lend support to the theory of Naeslund's.[7] It may be contended that as the organism was not isolated from

the teeth of the patient's children, the theory cannot be substantiated. Even if such an isolation were successful, the objection might have been offered that the children were infected from the diseased breast of the mother. The point, however, should not be overlooked that actinomycosis of the breast, in spite of the prevalence of prolonged lactation in this country, is an extremely rare lesion. It may, nevertheless, be presumed that if the maternal breasts are frequently traumatized by the teeth of older children, the infection may be accidentally transmitted from the carious or diseased teeth. The pathogenesis of primary mammary actinomycosis may be explained in this way.

SUMMARY

1. Actinomycosis of the breast may be secondary to that in the lung and pleura, but appears to be rare. Primary actinomycosis of the breast is rarer still. An interesting case of this condition is here recorded. The patient was a multiparous female, who habitually practised prolonged lactation. There was a history of recurrent attacks of mastitis in the breast.

2. Another unpublished case of mammary actinomycosis of eight years' duration in a multiparous female is recorded. The condition was mistaken for a scirrhous carcinoma, but a post-operative diagnosis was made.

3. The diagnosis of mammary actinomycosis is obviously difficult. Even when the ulcerative stage has been reached there is nothing characteristic to exclude other mammary affections. In very chronic cases the so-called ' sulphur granules ' may not be easily obtained.

4. The pathogenesis of mammary actinomycosis is not quite clear. The suggestion is made here that if the maternal breasts are frequently traumatized by the teeth of older children, the infection may be accidentally transmitted from their carious or diseased teeth. There is little doubt that *Actinomyces bovis* is a normal inhabitant of the human mouth. Prolonged lactation is not an uncommon practice in India. It is further encouraged by the popular belief that it acts as a deterrent to pregnancy.

In conclusion, we wish to thank our house staff, and in particular Dr. Amar Datta Gupta, the Surgical Registrar, and Dr. Bhupen Mukherjee, the Clinical Pathologist, for their valuable help.

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[4] Polichetti, E., *Gazz. internaz. Med.-Chir.*, 1930, xxxviii, 105.
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[6] Topley, W. W. C., and Wilson, G. S., *The Principles of Bacteriology and Immunity*, 2nd ed., 1936, 992. London: Edward Arnold & Co.
[7] Naeslund, C., *Acta pathol. et microbiol. Scand.*, 1929, vi, 66, 78.
[8] Lord, F. T., and Trevett, L. D., *Jour. of Infect. Dis.*, 1936, lviii, 115.

GASTROSCOPIC APPEARANCES IN HEALTH AND DISEASE

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INTRODUCTION

THE various appearances of the stomach as seen with the gastroscope are difficult to describe adequately without some means of illustration. Photography has been employed, but even the use of coloured films has proved unsatisfactory, as only the gross changes in the colour of the mucosa can be illustrated. It is possible however, to show any degree of variation by means of coloured pictures, and thus they are an indispensable form of illustration in gastroscopy.

The colour of the normal gastric mucosa can best be described as a red merging to orange, the intensity of this colouring and the preponderance of red or orange depending on the power of the illumination and the distance of the mucosa from the lens. The changes from the normal colouring are described under each of the pathological conditions illustrated.

In the preparation of this series of illustrations, the operator and the artist have collaborated over a considerable period to make the pictures an accurate reproduction of the conditions illustrated. Where possible a number of cases of each condition were examined, and from one selected as typical a watercolour drawing was made. A careful comparison was then made between the picture and other cases at the actual time of the gastroscopic examination.

For the purpose of illustration these paintings have been enlarged in comparison with the size of the gastroscopic field.

I wish to thank the Honorary Staff of the Liverpool Royal Infirmary for their encouragement and for allowing me to examine cases under their care. I am especially grateful to my chief, Mr. H. F. Woolfenden, and to Professor R. E. Kelly and Professor Henry Cohen.

I am indebted to those who introduced me to the technique of gastroscopy, and furthermore to Mr. Harold Edwards for his helpful advice on a number of occasions.

It gives me great pleasure to thank the Editorial Committee who have so generously given a grant towards the publication of these pictures.

Finally I wish to thank Mr. D. J. Kidd, medical artist, for the patience, skill, and interest which he has shown whilst preparing the paintings.

NORMAL APPEARANCES

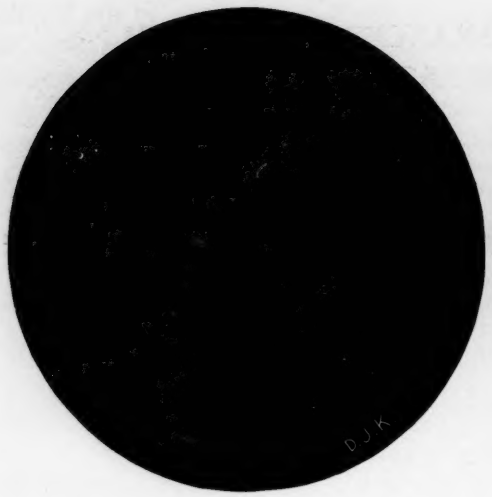

FIG. 37.—Cardiac orifice. Normally this view is not obtained. In this case, owing to the presence of a mediastinal neoplasm, the lower part of the œsophagus was pushed over and the major portion of the cardiac orifice seen. The mucous membrane of the œsophagus is more red than that of the stomach, which is here seen partially illuminated through the orifice. The longitudinal rugæ of the œsophagus have been obliterated by air distension.

FIG. 38.—Lesser curvature. The rugæ are obliterated by slight air distension, so that the mucosa appears as a smooth surface. That portion of the field nearest to the lens is more illuminated than the rest, and therefore appears paler.

FIG. 39.—Anterior wall. The rugæ appear few and low when the stomach is slightly distended. They completely disappear as distension is increased.

FIG. 40.—Greater curvature. The rugæ of this wall are more prominent than those of the other walls and run parallel to the long axis of the stomach. They do not completely disappear with full air distension. The pool of mucus is shown.

FIG. 41.—Posterior wall. The rugæ are shorter and less marked than those of the greater curvature. They form a complex pattern, and only disappear with full air distension of the stomach.

FIG. 42.—Prepyloric physiological sphincter. This forms the entrance to the pyloric antrum, and appears as a slit. It is not often so pronounced as shown, but when found must not be mistaken for the pylorus.

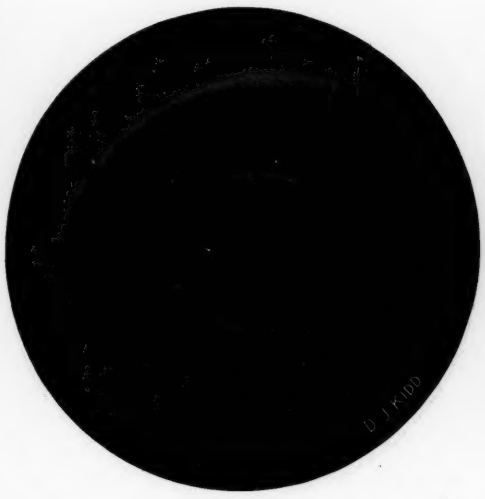

FIG. 43.—Pylorus. A portion of the pyloric antrum with the pylorus partly contracted can be seen. The angulus is shown in the upper part of the picture.

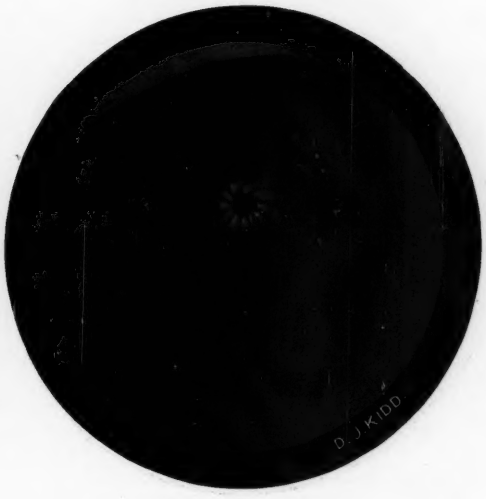

FIG. 44.—Pylorus. The pylorus is shown almost completely closed and the mucosal folds are slightly twisted as the sphincter closes. A view of the completely closed pylorus is not always obtained.

GASTRITIS

FIG. 45.—Acute catarrhal gastritis. The mucous membrane of the greater curvature is shown red in colour, with thickened mucus adherent between the rugæ. Small submucous hæmorrhages can be seen. The pool of mucus is more viscid than normal.

FIG. 46.—Chronic hypertrophic gastritis. The rugæ are more pronounced than normal, and do not flatten as easily, so that those of the posterior wall are still present with full air distension. In an active phase, as shown here, the mucous membrane is a dusky red and loses its normal lustre, giving a rather 'matted' appearance.

FIG. 47.—Chronic hypertrophic gastritis. This shows the passive phase, with numerous granulations or 'warty' projections on the rugæ.

FIG. 48.—Chronic hypertrophic gastritis. This view shows the lesser curvature involved with a nodular type of hypertrophy. This type is sometimes difficult to differentiate from a non-ulcerative nodular carcinoma.

FIG. 49.—Atrophic gastritis. All the rugæ completely disappear with air distension. The mucous membrane is much paler than normal, whilst the vessels, which normally cannot be seen, appear as fine irregular threads.

FIG. 50.—Syphilitic gastritis. This is the appearance of the lesser curvature, which is coarsely nodular and has entirely lost its redness. Scarring of the mucosa is shown.

BENIGN ULCERS

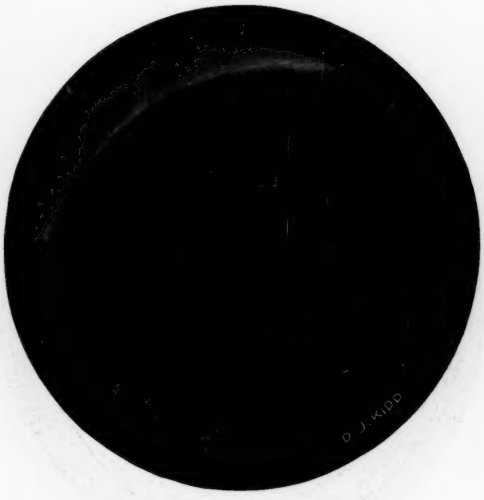

FIG. 51.—Subacute ulcer. This ulcer is not associated with a chronic hypertrophic gastritis. It is seen in the pyloric antrum, is shallow, and involves the mucous membrane only. This patient complained of indigestion associated with stomal ulceration, and a gastroscopic examination during these attacks revealed the above type of lesion.

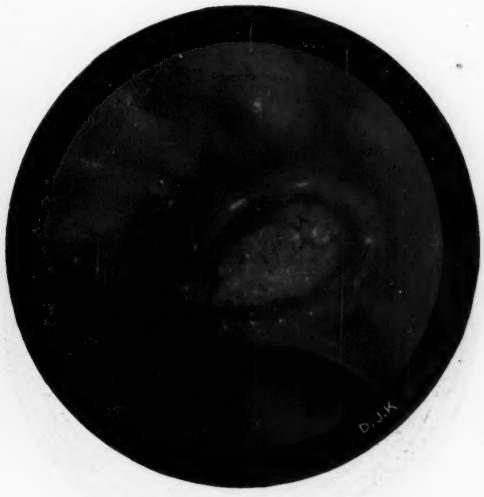

FIG. 52.—Chronic ulcer. This is situated on the lesser curvature near the angulus. There is a hyperæmia of the surrounding mucosa with œdema of the edge, showing that the ulcer is in an active phase. The floor consists of yellowish debris.

FIG. 53.—Chronic penetrating ulcer. The ulcer is present on the posterior wall and the floor is of greyish colour, due to penetration into the pancreas.

FIG. 54.—Chronic ulcer. This is a close view of an active ulcer of the posterior wall. The rugæ are markedly œdematous and cannot be obliterated with air distension.

FIG. 55.—Chronic ulcer. This is the appearance of *Fig.* 54 after one week of intensive medical treatment. The œdema is subsiding and the rugæ are therefore becoming less marked.

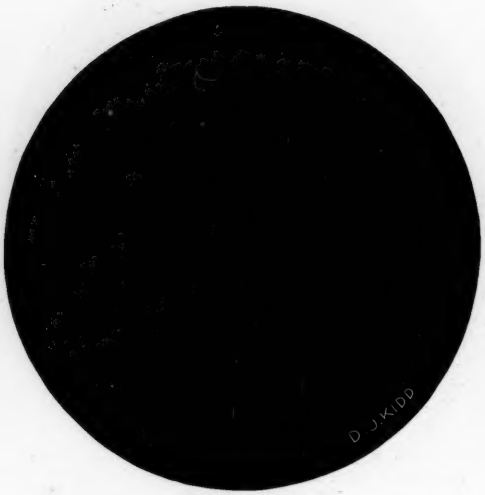

FIG. 56.—Healed ulcer. A stellate scar can be seen in the pyloric antrum.

BENIGN DEFORMITIES

FIG. 57.—Cardiospasm. A peristaltic wave can be seen moving towards the contracted cardiac end of the œsophagus.

FIG. 58.—Diverticulum. The clean punched-out appearance of the orifice of the diverticulum is seen on the anterior wall. It is probably of congenital type.

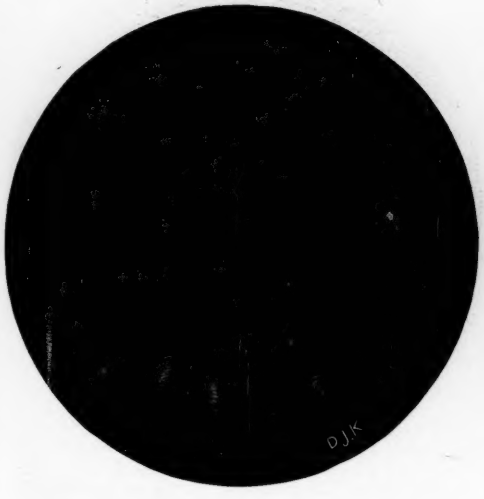

FIG. 59.—Hour-glass contraction of the stomach. The contracted portion of the stomach between the two sacs is shown.

FIG. 60.—Pyloric stenosis. The pylorus is shown at its maximum relaxation; the stenosis was due to cicatrization on the duodenal side.

POST-OPERATIVE CONDITIONS

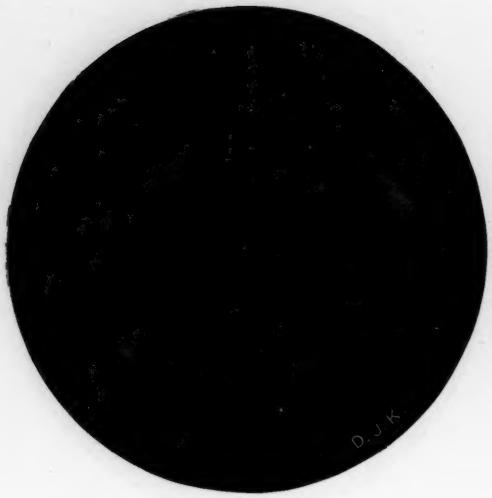

FIG. 61.—Anastomotic ulcer. The stoma is shown with the mucous membrane rather congested, and a small ulcer is seen on the anastomotic line.

FIG. 62.—Jejunal ulcer. The edge of the gastro-enterostomy stoma and the valvulæ conniventes of the jejunum are shown. The major portion of a chronic ulcer can be seen.

FIG. 63.—Partial gastrectomy stoma. The mucous membrane of the small intestine is more brown in colour than that of the stomach. There is usually a sphincteric action to be seen at the stoma. (Polya type of gastrectomy.)

FIG. 64.—Pyloroplasty. The normal shape of the pylorus is lost. Duodenal regurgitation is shown, and a granular appearance due to gastritis is seen on the right of the picture.

NEOPLASMS

FIG. 65.—Polyp. The pedunculated polyp is attached by a narrow pedicle to the greater curvature. There is slight œdema of the adjacent rugæ.

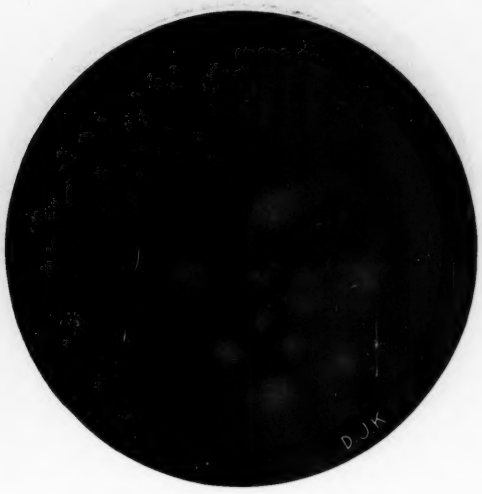

FIG. 66.—Early carcinoma. A few submucous nodules are shown. The mucous membrane is unbroken.

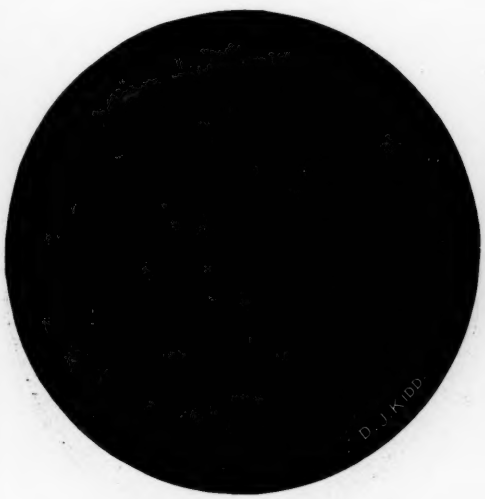

FIG. 67.—Early carcinomatous ulcer. A figure-of-8 appearance is shown as the wave has reached the pylorus, the lower half being due to an early carcinomatous ulcer. The lower part of the ulcer shows a slightly nodular appearance, there is no œdema of the edge, and no deviation of the colour from normal.

FIG. 68.—Carcinomatous ulcer. This is a typical malignant type of ulcer with nodular raised edge and a sloughing base, which still contains a few particles of barium.

FIG. 69.—Carcinomatous ulcer. An ulcer of the lesser curvature near the angulus is shown. The floor is dirty grey, the edge is rigid and nodular, whilst there is no œdema. The adjacent mucosa is pale in colour due to anæmia.

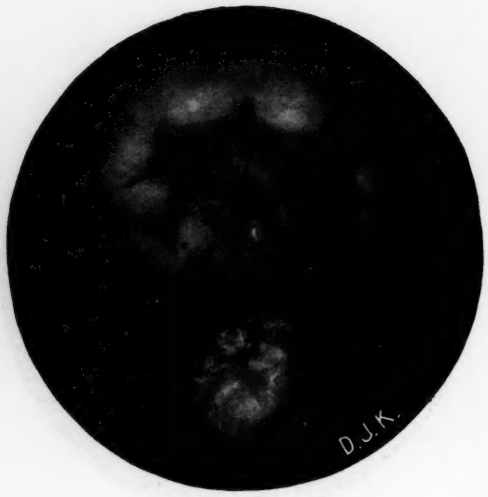

FIG. 70.—Malignant pylorus. The nodular appearance around the contracted pylorus can be seen. There is still some barium in the stomach.

FIG. 71.—Diffuse scirrhous carcinoma (leather-bottle stomach). The rugæ are rigid in appearance. The colour of the mucous membrane is pale, with an underlying white nodular appearance. These rugæ do not distend with air inflation, and bleeding is easily obtained.

FIG. 72.—Diffuse scirrhous carcinoma. This shows extensive carcinoma of the lesser curvature with nodulation, an ulcer, and an adjacent fistula which the radiograph suggested was of gastro-omental type.

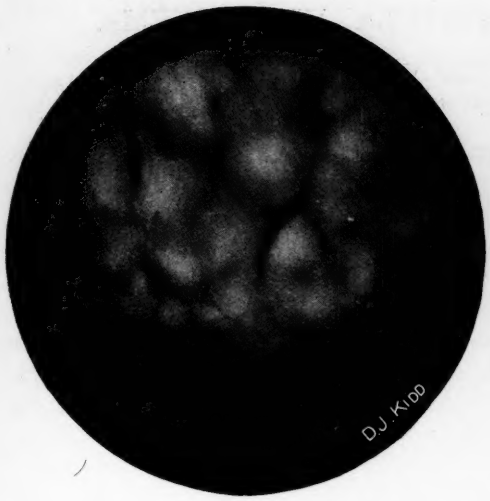

FIG. 73.—Papilliferous carcinoma. A large projecting papilliferous mass is seen arising from the lesser curvature. Two small hæmorrhagic areas are present.

FIG. 74.—Papilliferous carcinoma. A bleeding lobulated mass is seen projecting into the lumen of the stomach.

FIG. 75.—Papilliferous carcinoma. This mass appears rather 'fleshy' and has a 'dirty' background.

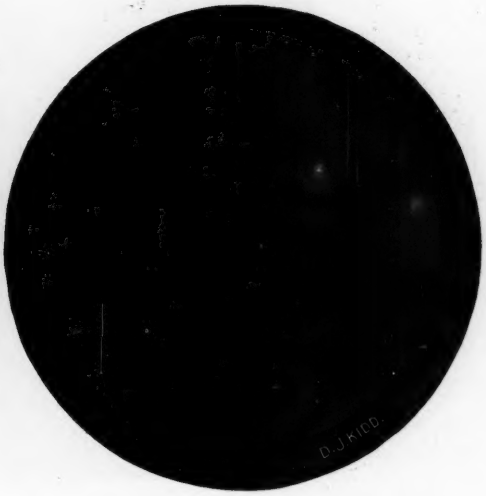

FIG. 76.—Papilliferous carcinoma. This is similar in appearance to *Fig.* 75, although more red in colour. It was found in a male aged 24, and at operation was too extensive for removal.

PLEURO-ŒSOPHAGEAL FISTULA IN EMPYEMA

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PERFORATION of the œsophagus by foreign bodies, by corrosive poisons, and by carcinoma is not uncommon. Spontaneous and traumatic ruptures also are described in many text-books of surgery, but in spite of its nearness to the pleural cavities, perforation of the œsophagus by an empyema is almost unknown.

A case is reported here of an empyema which, while it was draining through a thoracotomy wound, perforated the œsophagus and thus produced a pleuro-œsophageal fistula. A synopsis is given of eight similar cases collected from the literature. In addition two cases of œsophageal fistula associated with intrathoracic suppuration of unknown origin are briefly described, but are not included in the subsequent discussion.

CASE REPORT

W. G., a male 54 years old, was admitted to the North Middlesex Hospital, April 3, 1936, with a right-sided pneumonia which was followed by an empyema. He gave a vague history of having suffered from indigestion for many years. Radiographs, after the development of the empyema, showed the usual signs of fluid in the pleural cavity, but no gas. Pus withdrawn through a needle gave a pure culture of *Sta. aureus*.

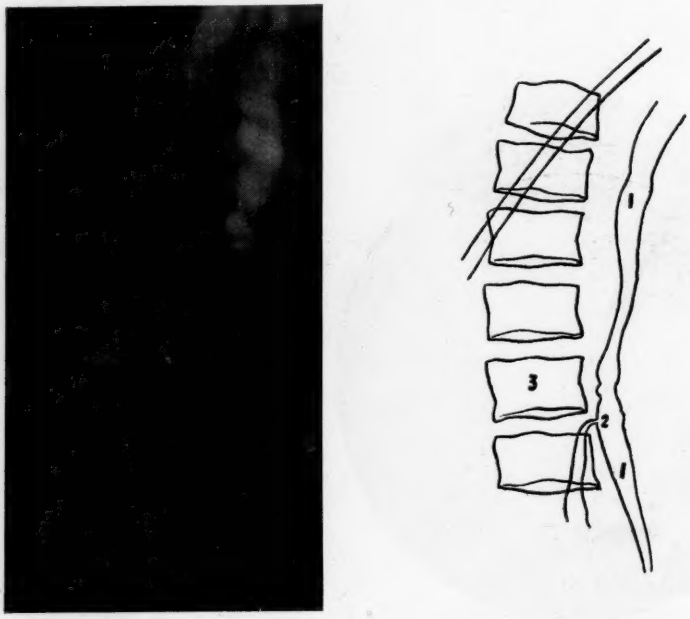

Fig. 77.—Radiograph showing barium entering the right pleural cavity through a fistula of the œsophagus at the level of the eighth dorsal intervertebral disc. On the wall of the œsophagus opposite the opening of the fistula is a rounded shadow resembling a diverticulum. The lung is collapsed. Right anterior oblique view. The key diagram shows: 1, Œsophagus; 2, Barium escaping from the œsophagus and the fistula into the empyema cavity; 3, Eighth dorsal vertebra.

FIRST OPERATION.—On April 23 a portion of the eighth rib was removed under pentothal sodium anæsthesia (5 c.c.), and a Tudor Edwards tube inserted through the opening.

SUBSEQUENT PROGRESS.—On the twenty-seventh day after operation particles of altered food were seen on the dressing. Examination of a specimen of the discharge showed it to be slightly acid to litmus, but it contained no free HCl.

X-ray examination (*Fig.* 77) on May 21 revealed signs of a fistula between the œsophagus and the empyema cavity. The fistula was approximately half the diameter of the œsophagus in length, and it led backwards from its opening on the posterior wall of the œsophagus at the level of the disc between the eighth and ninth dorsal vertebræ.

FIG. 78.—Posterior view of specimen removed post mortem. A fistula is present between the œsophagus and a right-sided empyema cavity. (× ⅛.)

Œsophagoscopy on October 28 showed the opening of the fistula on the posterior wall of the œsophagus in its middle third. Pus was noticed exuding from the hole, but no diverticulum, foreign body, or new growth was seen.

The patient refused further treatment and left hospital on November 6, with the thoracotomy wound closed. A simple radiograph taken before he left showed signs of fluid in the empyema cavity and collapse of the lung, so that presumably the fistula was still open. On December 3 the patient was re-admitted to hospital with pus and partly digested food escaping

from the wound, which had re-opened. The empyema cavity was irrigated daily with a weak solution of eusol.

SECOND OPERATION.—On December 12, under novocain local anæsthesia, an additional portion of the eighth and about five inches of the ninth ribs were removed in order to provide better drainage. At this operation the fistula was seen as a round hole, about three-eighths of an inch in diameter, on the posterior wall of the œsophagus. Curdled milk was observed coming from the opening. It was noticed at the same time that the wall of the œsophagus in the vicinity of the fistula was covered with a smooth layer of firm fibrous tissue, which beyond the œsophagus became continuous with the fibrous tissue on the mediastinal wall of the empyema cavity. The fistula was not disturbed, and the operation was completed by packing the cavity lightly with gauze and inserting a rubber tube.

Irrigations of eusol were resumed after removal of the gauze packing. No local or general spread of infection occurred. Death took place on March 1, 1937, nine months after food was first noticed in the empyema dressing.

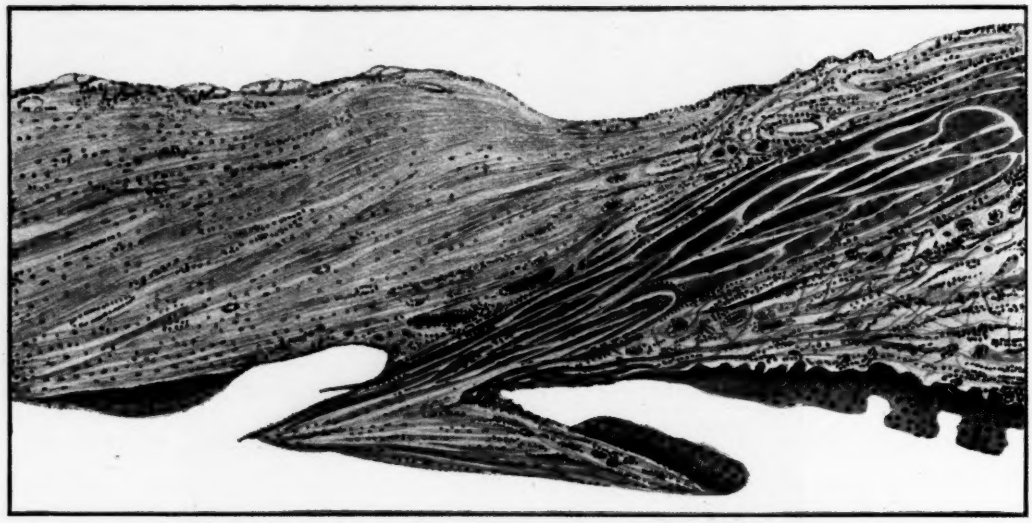

FIG. 79.—Vertical section through the posterior wall of the fistula seen in *Fig.* 78. Œsophageal portion of the fistula on the right, and pleural portion on the left. (× 5.)

POST-MORTEM FINDINGS.—General signs of toxæmia were present, but no pyæmic abscesses. A simple fistula lay between the œsophagus and a right-sided empyema cavity (*Fig.* 78). The fistula, half an inch in length, was situated four inches from the cardiac orifice, and it sloped gently upwards to its opening into the pleura. The empyema cavity extended up to the level of the second rib, and the lung was collapsed to about one-third its normal size. The presence of firm fibrous tissue, as noticed at the second operation, was confirmed. That part of the œsophagus situated below the fistula was dragged about half an inch to the right of its normal position by the empyema. No suppuration of the mediastinal lymph-glands was found.

Microscopical examination of the posterior wall of the fistula (*Fig.* 79) shows an œsophageal portion comprising all the normal layers of the œsophagus, and a pleural portion composed of dense fibrous tissue. The pleural portion is slightly less thick than the œsophageal. The fibrous tissue of the pleural and the external connective tissue of the œsophageal parts are continuous. Close to the juncture of the two portions of the fistula the submucous and part of the mucous layers of the œsophageal portion are deficient, and the muscle layer projects for a short distance into the lumen. Beyond this muscle spur a modified squamous epithelium is continued for some distance along the pleural portion of the fistula, which is thus in process of becoming epithelialized.

SYNOPSIS OF CASES FROM THE LITERATURE

Case 1. VOELCKER, 1891.—Boy, aged 6½. Admitted to hospital with a left-sided empyema and a history of spitting up blood and phlegm for eight months. Portions of the fifth and ninth ribs were removed, and six months later curdled milk was observed escaping from the wound. The resulting fistula persisted for nine and a half months when it was decided to do a gastrostomy, but the operation was abandoned because of adhesions in connection with the stomach. Three days later the patient died. At autopsy two fistulæ were found opening into the left side of the œsophagus, opposite the eighth and ninth dorsal vertebræ. The side of the bodies of the fourth, fifth, and sixth dorsal vertebræ were eroded by the empyema. No foreign body or diverticulum was found. The posterior mediastinum contained caseous lymph-glands, but there was no evidence that one had ruptured into the œsophagus or pleura.

Case 2. THURSFIELD, 1901.—Boy, aged 4½. Entered hospital with an empyema necessitatis which resulted in two sinuses between the fifth and sixth ribs on the right side of the chest. Rib resection was done close to the sinuses. Later, pieces of two more ribs were removed to improve the drainage, and in four days' time curdled milk was noticed in the dressings. Death occurred after two weeks. At post-mortem, opposite the head of the third rib, there was found an opening in the œsophagus "the size of a No. 3 red rubber catheter". No foreign body, tuberculosis, or amyloid disease was discovered. Thursfield believed that the fistula was due to ulceration of the œsophagus by the empyema.

Case 3. BALLIN and SALTZSTEIN, 1922.—Boy, aged 15. Admitted to hospital with a right-sided pyopneumothorax due to lobar pneumonia. Two inches of the seventh rib was removed, and eight days later particles of food were seen in the dressing. X rays, after a barium swallow, showed signs of a fistula of the œsophagus at the level of the fourth dorsal vertebra. For three weeks food was given through a Rehfuss tube. Recovery was complete one year after the operation of rib resection.

Case 4. VOSS, 1923.—Boy, aged 8. A left-sided empyema followed an attack of influenza and a fluctuating swelling formed below the left nipple. Mixed flora were found in the pus withdrawn from the pleural cavity, and marked fœtor of the breath was present, although no vomiting or coughing up of pus occurred. Two days after excision of a portion of the tenth rib pieces of food were observed in the dressing. Three times daily nourishment was administered through an œsophageal tube, and three weeks later, i.e. two months after the thoracotomy operation was performed, the fistula had closed. No radiographic findings are recorded.

Case 5. ACUNA and BETTINOTTI, 1930.—Girl, aged 2½. In the fluid withdrawn by aspiration of a right-sided empyema pneumococci, *B. pfeiffer*, various Gram-positive cocci, and clotted milk were discovered. Repeated aspiration and irrigation were employed, and later a portion of a rib was excised. Gastrostomy was resorted to, but twenty-four hours later the patient died. Post-mortem examination showed a fistula between the œsophagus and the empyema cavity at the level of the bifurcation of the trachea.

Case 6. MIKULA, 1931.—Child, aged 11. Empyema followed a right-sided pneumonia, and thoracotomy was performed. Particles of food were later observed in the dressing. Screening, after swallowing an opaque fluid, showed food leaving the œsophagus at the level of the bifurcation of the trachea. Gastrostomy was done, and five months later X rays showed that the fistula had closed. Details regarding the gastrostomy are not given.

Case 7. WALL, 1932.—Boy, aged 11. Developed an œsophageal fistula eleven days after thoracotomy for a left-sided empyema which complicated influenza. X rays, after swallowing iodipin, showed the opening in the œsophagus at the level of the sternoclavicular joint. Two months after the operation X rays showed no signs of the fistula, and complete recovery ensued. For a short time while the fistula was discharging food, rectal feeds were given.

Case 8. CAUBARRERE, 1934.—Child, aged 8. Thoracotomy was performed for a left-sided empyema, and six days later altered food was noticed in the discharge from the wound. X rays, after an opaque swallow, showed signs of a fistula of the œsophagus at the level of the sternoclavicular joint. Two months later X rays showed no sign of the fistula, and the thoracotomy wound also had closed.

TWO CASES OF PLEURO-ŒSOPHAGEAL FISTULA OF UNCERTAIN AETIOLOGY

MACLACHLAN, 1860.—Female, aged 25. Along the inner border of the right breast were three fistulous openings which discharged food almost immediately after it was swallowed. The fistulæ followed the incision of an abscess, and there was a history of pain, fever, rigors, and cough with purulent sputum for eleven years before. Hæmoptysis occurred just before the abscess was opened. No final history is recorded. Maclachlan thought his patient originally had an 'abscess of the lung' which communicated with the pleural cavity, but he did not know in what part of the œsophagus the fistula opened.

OSLER, 1893.—Male, aged 34. A fistula near the right nipple had discharged food, according to the history, for more than seventeen years. This fistula resulted from the breaking down of an abscess, which was present as a swelling for at least three years; and intermittent pain with profuse expectoration preceded the appearance of the swelling also by a number of years. The patient apparently was seen only twice during a period of two weeks, so that the later history is unknown. Osler believed, however, that the primary condition was a "circumscribed empyema", which at first drained through the lung, and subsequently tracked through the anterior chest wall.

Comment.—These two cases differ from those previously quoted, except Voelcker's, in their long period of onset. They resemble them in that they were associated with intrathoracic suppuration of some sort. It is possible that in these two cases also, the fistula was the result of an empyema. Osler's case is of exceptional interest, in that the fistula was present and periodically discharged food for seventeen years.

DISCUSSION

Anatomical Relations of the Œsophagas.—The thoracic part of the œsophagus is situated in the superior mediastinum above, and in the posterior mediastinum below. In the superior mediastinum, above the level of the bifurcation of the trachea, the œsophagus is separated from the mediastinal surface of each lung by the visceral and mediastinal pleuræ and the intrapleural space. Here, in its upper part, the œsophagus is placed slightly to the left, but lower down it comes to lie in the midline of the body. In front of the œsophagus is the trachea, and behind it are the bodies of the upper four thoracic vertebræ. In its course in the posterior mediastinum, opposite the fifth to the eighth thoracic vertebræ, the œsophagus inclines from the midline above to a position slightly to the left of the midline below. In front are the posterior mediastinal lymph-glands, which receive vessels from the œsophagus and the mediastinal pleura. On each side, as in its superior mediastinal course, the œsophagus is in relation with the lung, the two layers of pleura, and the intrapleural space.

Clinical Features.—

Age.—With the exception of the author's case (aged 54), the cases in this analysis were all children; the youngest was $2\frac{1}{2}$ years, the oldest 15.

Sex.—Males, 6 cases; female, 1 case; in 2 cases the sex was not stated.

Cause of the Empyema.—Pneumonia, 4 cases; "influenza", 2.

Bacteriology.—Sta. aureus, 1 case; pneumococcus, 1 case; mixed flora, pneumococci, *B. pfeiffer*, and various Gram-positive cocci, 1 case. (It is unfortunate that the bacteriology is noted in only 3 cases.)

The Side Affected.—There were 5 of the empyemas on the right side; 4 on the left.

Level of the Fistula.—The fistula was opposite the ninth dorsal vertebra in 2 cases; the fourth dorsal vertebra in 3 cases; the third dorsal vertebra in 1 case; the second dorsal vertebra in 2 cases; and the position was not stated in 1 case. The lesion, therefore, was in that part of the œsophagus lying in the superior mediastinum in 6 cases; in the posterior mediastinum in 2 cases.

Time of First Appearance of Food after Thoracotomy.—In 1 case the time is not stated, but in the remaining 8 cases the periods are: immediately, 2 days, 4 days, 6 days, 8 days, 11 days, 27 days, and 6 months. In at least 7 of the 9 cases, particles of food were observed in less than one month after the operation of rib resection. It may be said, therefore, that if an œsophageal fistula does not supervene within one month of a thoracotomy operation for empyema it is very unlikely to occur.

Duration of the Fistula.—In the 5 cases which recovered, the fistula persisted on an average for four months; the longest time was about one year, the shortest two months. In 3 of the 4 cases which died, the fistula persisted for periods of two weeks, nine months, and nine and a half months; in the remaining case, which died, the period is not recorded.

Frequency.—The cases were published in the years 1891, 1901, 1922, 1923, 1930, 1932, 1933, and 1934.

Since the treatment of empyema by some form of drainage has been practised for over ninety years, such an unusual phenomenon as food in the pleural cavity is not likely to have escaped observation altogether, and it seems reasonable to conclude that the condition has occurred more frequently of recent years than in the past.

Seven of the cases in the series occurred in the last two decades, and all nine since Arbuthnot Lane, in 1882, first advocated primary rib resection for acute empyema. If, as is suggested by the evidence, the complication of pleuro-œsophageal fistula is becoming more frequent, its relation to the modern treatment of acute empyema may require further investigation.

PATHOGENESIS

Four theories to explain the formation of the fistula will be critically examined in connection with the cases surveyed.

1. Perforation of the Œsophagus and the Empyema Wall by Inflammation of the Mediastinal Lymph-glands.—Perforation of the œsophagus alone, the result of inflammation spreading from the mediastinal lymph-glands, has been described by Zuppinger. He records a case of his own, and quotes similar ones from Korner, Voelcker, and Verliae. The patients all suffered from tuberculosis, and at post-mortem examination a perforation of the œsophagus was found at the level of the bifurcation of the trachea. In the same article, Zuppinger notes the case of a tuberculous child in whom there was found at autopsy a communication between the trachea and the œsophagus through an abscess of the mediastinal glands, and he refers also to similar cases reported by Leblond, Polandt, and Quincke.

Zuppinger mentions no case of an abscess of the mediastinal lymph-glands rupturing into both the œsophagus and an empyema, and in the cases reviewed in the present paper there is no proof of such an event having occurred.

2. Perforation of a Diverticulum of the Œsophagus.—A diverticulum of the œsophagus might become infected and perforate into the pleural cavity, causing an empyema. Or, conversely, an empyema might infect and gradually perforate a diverticulum of the œsophagus.

Of the cases considered in this article, 4 of them died and came to post-mortem, and no diverticulum was discovered, although in 2 of them the fistula was near the bifurcation of the trachea, the level at which traction diverticula commonly occur. In 2 at least of the 5 cases which recovered the fistula was in the same situation. The radiographic description in these two cases makes no mention of a diverticulum. It must be concluded, therefore, that adequate evidence of the existence of a diverticulum in any of the cases is lacking.

3. Perforation of a Peptic Ulcer into an Empyema.—A peptic ulcer of the œsophagus has been known to perforate into the pleural cavity, and an interesting example of this is recorded by Christie; but as far as can be ascertained no peptic ulcer has perforated into an empyema. The patients in the collected series of cases were all under 16 years of age, so that the presence of a peptic ulcer is extremely unlikely. In the author's case the patient, a man of 54, gave a history of indigestion for many years, but histological examination of a portion of the wall of the fistula showed no signs of a peptic ulcer.

4. Perforation of the Normal Œsophagus by an Empyema.—The pathological events as conceived by this theory are: empyema, inflammation of the wall of the œsophagus, ulceration or necrosis, and perforation. The actual rupture of the weakened œsophageal wall might well occur during the physiological act of swallowing.

In all except one case (Case 5) of the series an empyema was known to precede signs of the fistula, so that on clinical grounds the empyema may be regarded as its cause. No abnormality of the œsophagus was detected in those cases (Cases 3, 6, 7, 8, and the author's) in which an X-ray examination was made. The post-mortem specimen from the author's case (*see Fig.* 78) shows the œsophagus dragged to the right, direct evidence that it had been subjected to inflammatory forces from without.

TREATMENT AND RESULTS

The mortality-rate in the series is 44 per cent. The main dangers of the condition are toxæmia and starvation. Four rational methods of treatment may be considered: (1) Thoracotomy by rib resection; (2) Feeding through an œsophageal tube; (3) Gastrostomy; (4) Direct closure of the fistula. The series of cases under consideration is so small that conclusions drawn from the results of any particular form of treatment are likely to be misleading. But it may be of value to note that the best results followed the simplest form of adequate treatment, viz., rib resection combined with feeding through an œsophageal tube.

1. Rib Resection.—Although this treatment is especially indicated for the empyema, it is not sufficient for the cure of the fistula once this has formed. It was employed in 5 cases of the series with 3 deaths—a mortality-rate of 60 per cent.

2. Feeding through an Œsophageal Tube.—Employed with rib resection, this gave the best results in the quoted cases. In *Case* 3 food was administered by means of a Rehfuss tube for three weeks during the time the fistula was present,

and in *Case* 4 food was given through an œsophageal tube for a similar period. Both cases recovered. Feeding through a tube would appear to have been of doubtful value in the author's case because altered food was observed coming from the fistula some time after it was passed into the stomach—an indication that regurgitation was occurring.

3. Gastrostomy.—This was performed after rib resection in *Case* 5, which died; and in *Case* 6, which recovered. Ballin and Saltzstein say of the operation: "It may be indicated if the food discharge threatens to lead to starvation". Voelcker said in connection with his case: "Had gastrostomy been practicable, this might have prolonged the child's life". But here again, regurgitation might well occur into the œsophagus.

4. Direct Closure of the Fistula.—In no instance, so far, has this been attempted. In the author's case, since no closure seemed to be taking place after many months, it has been suggested by Mr. Ivor Lewis that direct closure of the fistula by a pedicled flap cut from the adjacent fibrous tissue would be, at least, a feasible anatomical proposition. If undertaken, he recommended that a thoracoplasty, so designed as to give adequate exposure of the œsophagus, be combined with the operation.

A thoracoplasty alone, by completely obliterating the empyema cavity might close the fistula, but in practice it would probably not be considered until simpler methods had failed. By this time fibrosis will have occurred in the wall of the fistula and food regurgitated, so that the operation is unlikely to be successful.

SUMMARY

1. Nine cases of pleuro-œsophageal fistula due to empyema are described.
2. The mortality-rate for the nine cases is 44 per cent.
3. The condition is rare, but appears to be increasing in frequency.
4. Theories regarding the causation of the fistula are discussed.
5. A new method of treatment is suggested.

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RIEDEL'S THYROIDITIS AND ITS TREATMENT BY RADIUM

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RIEDEL'S thyroiditis is a rare condition, but not quite so infrequent as is commonly thought. It is an advancing condition of the thyroid gland which is characterized clinically by an enlargement of the gland of peculiar iron-hard consistence, attended by dysphagia, dyspnœa, and dysphonia, and histologically by varying degrees of lymphocytic infiltration and fibrosis of the gland and surrounding structures, with alteration and atrophy of the epithelial elements. Within the last twenty years several authors have contributed from 1 to 8 cases each, and recently Eisen (1936, November) has reviewed the literature critically and accepted 82 of the 187 reported cases. He has also computed the incidence of Riedel's thyroiditis in proportion to the total number of thyroidectomies in recorded instances to be 0·20 per cent. The highest incidence then obtaining was 0·98 per cent (Schultz), with 3 cases in 305 thyroidectomies. Crile states that cancer occurs in about 2 per cent of thyroidectomies, or ten times more frequently than Riedel's thyroiditis. In the last decade there have been 418 thyroidectomies conducted in the Western Infirmary, Glasgow, and 7 cases of Riedel's disease and 7 cases of cancer have been encountered, giving an incidence of 1·7 per cent in each.

The object of this communication is to report on a small series of 5 cases which were treated by radium. The method was adopted following on the surprisingly rapid cure of a case of supposed malignant growth of the thyroid. Re-examination of the histological preparations proved it to be a case of Riedel's thyroiditis. Of the 5 cases treated, 3 were diagnosed as Riedel's struma on histological evidence, and the other 2 on clinical and therapeutic grounds.

The treatment of Riedel's thyroiditis is generally accepted to be surgical; thus Joll (1932) writes that there should be "removal of as much of the affected gland as is compatible with avoidance of important structures in the neck", and Benson states that "if a subtotal, partial, or complete thyroidectomy cannot be performed, at least a wedge-shaped piece should be removed from the isthmus, freeing the trachea". Joll concludes that "in Riedel's disease proper, as distinguished from other forms of chronic thyroiditis and lymphadenoid goitre, there is neither theoretical nor practical basis for belief in the value of treatment by X-rays or radium". In the condition classified 'lymphadenoid goitre' he recommends conservative surgical measures. Nevertheless, from time to time X-radiation has

been employed with a definite measure of success, either as the only form of treatment or, more frequently, post-operatively. Thus, Delore and Alamartine (1911) quote a cure by radiotherapy reported by Barjon—duration, to the time of reporting, four years. Portman (Crile) considers that in Riedel's disease "when a clinical diagnosis can be made, roentgen therapy is the preferred treatment". But intensive radiation in his one case of 'struma lymphomatosa' was ineffective. Means (1937) records a case in which high voltage radiation was effective post-operatively in giving prompt relief of recurring symptoms. This case will be referred to later, since the dosage given is comparable to that used in our present series. In a review of the literature only two references to the use of radium have been encountered—"Maloney in addition to surgery has used radium successfully and seems to think it is specific" (Benson), and "one very large tumour produced severe dyspnœa from pressure, but receded rapidly under radium" (Ewing, 1928). This case, Ewing says, showed very extensive lymphocytic infiltration histologically.

CASE REPORTS

Case 1.—Mrs. M. C., aged 39, was admitted to the Western Infirmary on March 22, 1933. After the birth of her third child, five months before admission, she began to have a feeling of discomfort in the left side of her neck, and shortly afterwards a swelling appeared there. This increased in size, and was accompanied by breathlessness and a troublesome cough. About four months later she noticed an alteration in the tone of her voice. The whole thyroid was enlarged, especially on the left side. It was very hard and fixed. Some glands could be felt in the posterior triangle of the neck on both sides. The patient was inclined to be breathless. Examination of the vocal cords did not show any abnormality.

March 31, 1933.—Central portion of the isthmus removed by diathermy. Pathological report states that "the gland is the seat of a cellular malignant growth; the extraglandular structures, muscle, and fibrous tissue are invaded".

April 14, 1933.—Radium collar applied.

April 24, 1933.—Patient free from symptoms—breathlessness and cough gone, and the swelling of the thyroid has almost disappeared. Professor Sir Robert Muir re-examined the sections and was of the opinion that the condition was one of Riedel's thyroiditis.

April 27, 1933.—Thyroid swelling and glandular enlargement have disappeared completely.

March 1, 1938.—Patient remains perfectly well.

Case 2.—Mrs. A. L., aged 50, was admitted to the Western Infirmary on September 3, 1934. She had had pain about her neck at intervals for the last five months, but it had been more marked during the last month. There was huskiness of the voice and occasional breathlessness. She stated that she had lost weight in the last few months. There was a hard uniform enlargement of the thyroid, but no enlarged glands were felt. Vocal cords appeared normal.

September 7, 1934.—A piece of the isthmus was removed by diathermy, and the histological diagnosis was Riedel's thyroiditis.

September 18, 1934.—Radium collar applied.

October 1, 1934.—Enlargement of thyroid almost gone.

January 3, 1935.—No thickening in the neck. Patient feels quite well.

January 15, 1938.—Patient remains quite well.

Case 3.—Mrs. C. N., aged 49, was admitted to the Western Infirmary on April 23, 1935. About two years previously she developed a swelling in her neck which was slightly painful. It remained about the same until a few weeks before admission, when it began to increase in size; she had breathlessness and difficulty in swallowing. Her voice became weak and disappeared at times. Her general condition was good. There was a hard enlargement of the thyroid, most marked in the isthmus and left lobe. No enlarged glands could be felt. The condition was diagnosed clinically as Riedel's disease.

April 25, 1935.—Radium collar applied.

May 10, 1935.—The swelling has completely disappeared and the patient feels quite well.

February 8, 1938.—Patient remains perfectly well.

Case 4.—Miss C. R., aged 43, was admitted to the Western Infirmary on January 2, 1934. For the previous year she had had difficulty in swallowing, and more recently had noticed a change in her voice. Examination showed a localized swelling, almost in the middle line, which was diagnosed as an adenoma of the thyroid. This was removed surgically. The pathologist reported that the tissue showed the typical changes of Riedel's disease.

April 4, 1934.—Patient is now feeling quite well.

August 26, 1936. She has begun to have difficulty in swallowing solids. There is no sign of swelling in the neck. A bougie passes easily, and examination with the œsophagoscope is negative.

March 24, 1937.—The difficulty in swallowing has become worse and the patient is thinner. In view of the histological diagnosis, a radium collar was applied.

April 10, 1937.—She is now swallowing normally.

January 20, 1938.—Remains quite well.

On examination of the records in the Western Infirmary of the various lesions of the thyroid gland treated with radium a case was observed which, from consideration of its history, appears to have been one of Riedel's disease; and it has therefore been included by the kind permission of Dr. Gavin Young.

Case 5.—Mrs. J. R., aged 72, was admitted to the Ear, Nose, and Throat Wards, under Dr. Gavin Young, in April, 1933, suffering from a uniform and rather hard swelling of the thyroid gland, of three months' duration. The patient complained that it was somewhat tender, and there was occasional hoarseness. No definite fixation could be made out. The case was regarded as one of carcinoma of the thyroid gland, and, as the patient's general condition did not permit of much interference, it was decided to give a palliative dose of radium without biopsy. What is now estimated to have been a dose of 1800 r was given in seventy-two hours' continuous treatment. There was rapid improvement, the thyroid swelling disappearing within a week or so and the voice steadily recovering. The patient was last seen on February 23, 1938, when she was very well and had no swelling of the gland.

CLINICAL COMMENT

The clinical similarity of Riedel's thyroiditis and malignant disease of the gland has long been recognized, and mistakes in diagnosis often occur in the first instance. The satisfactory response to radium treatment in our cases has been extraordinarily rapid and complete, in contrast to that in malignant disease—so much so that the use of radium would appear to be a means of distinguishing the two conditions.

Some alteration in the voice has been a constant symptom in these cases, although no definite abnormality in the vocal cords could be demonstrated. In two cases difficulty in swallowing has been present. In *Case* 4 this recurred about two and a half years after operative treatment, and, in spite of the fact that there was no swelling to be detected in the neck, it became increasingly worse, so that the patient was rapidly losing weight. The passage of bougies was only of temporary benefit, but after the application of a radium collar the condition cleared up completely.

None of the cases treated with radium have shown any sign of thyroid deficiency, nor has there been any tendency to recurrence of the condition, even after from two to five years. Although the number of cases treated has been small, the method is so safe and simple, and the results so uniformly good, that we feel that radium treatment should invariably be employed in cases of Riedel's thyroiditis.

TREATMENT BY RADIUM

Efficient radiological treatment of the neck has always presented considerable difficulty, and this is specially so where the method of ordinary surface application

of radium is used. With ordinary facilities, the maximum distance at which radium can be applied in this situation is usually 5 cm., with encirclement of three-quarters of the neck. Even when this treatment is carefully carried out and the skin given a dose of 6000 r in fourteen to sixteen days, the centre of the neck will receive not more than 4500 r. It is therefore clear from a physical point of view that such treatment cannot give anything approaching homogeneous intensities throughout the neck. Where considerable dosage has to be given by the external route alone, the radium collar will usually be replaced by the multiple fields of the radium beam, except when one is dealing with very radiosensitive lesions, or where the collar is being used for reinforcement of an intrabuccal dose. When the first case of Riedel's disease was presented for treatment, however, the *roentgen* was not in general use as a physical unit for gamma radiation, and surface dosage was still a doubtful question, as far as the skin effects produced by varying amounts of radium at varying distances were concerned. Moreover, it was a matter of some difficulty to estimate the depth effect of such surface treatments, and many applications of radium were then made at distances which now seem inadequate, since the use of large quantities of radium at greater distances was unsafe in the absence of more accurate methods of estimating dosage. This explains the small radium-skin distance employed in the first case, although this was regarded as one of malignant disease at the time when treatment was started. A translation of the technical details into modern terminology, as far as this is possible, shows that our first patient received at the skin of the thyroid region a dose of 2500 r delivered from a distance of 3 cm. in ninety-six hours of continuous treatment. This dose would obviously fall off very quickly within the tissues, but, as has been described above, the rapidity of response was astonishing, all obvious thyroid swelling having disappeared within two weeks. In view of this result one readily gave treatment to the other patients by simple surface methods with a similar result.

Some variations appear in the treatment details of the other cases, but these were largely dictated by the amounts of radium which happened to be available at the time, and they did not affect the results. The most recent case was treated at a greater distance, since, by the time the patient appeared, we were regularly using 5-cm. apparatus for the neck. This apparatus encircled three-quarters of the neck, but the other earlier moulds were more limited in extent, covering mainly the thyroid area. The filtration used was either 1·0 or 1·5 mm. platinum, and the dosage calculations followed the system enunciated by Paterson and Parker (1934). (*See Table I.*)

Table I.—PARTICULARS OF THE RADIUM TREATMENT OF RIEDEL'S THYROIDITIS

CASE NO.	DATE OF TREATMENT	SKIN-RADIUM DISTANCE	DOSE AT SKIN	DURATION OF TREATMENT	RESULT
1. Mrs. M. C. .. (Mr. Renton)	April 14, 1933	3·0 cm.	2500 r	96 hr.	Well
2. Mrs. A. L. .. (Mr. Renton)	September 18, 1934	3·0 cm.	3000 r	193 hr.	Well
3. Mrs. C. M. .. (Mr. Renton)	April 25, 1935	3·0 cm.	4000 r	122 hr.	Well
4. Miss C. R. .. (Mr. Renton)	March 24, 1937	5·0 cm.	2000 r	120 hr.	Well
5. Mrs. J. R. .. (Dr. Gavin Young)	April 12, 1933	3·0 cm.	1800 r	72 hr.	Well

The case reported by Means (1937), to which we have already referred, is the only one in the literature available to us in which details of radiation therapy are given. Clinically this case is similar to our *Case* 4 as regards the post-operative recurrence of symptoms of obstruction, and the prompt relief of these following radiation. We wish therefore to include the notes of this case in summary form.

J. H. MEAN'S CASE.—

Case No. 13796.—Mrs. H., a woman of 60, complained of increasing frequency of attacks of paroxysmal coughing of ten years' duration, painful dysphagia, and dyspnœa of two months' duration and hoarseness for one and a half months. B.M.R. – 18. Enlarged, hard, irregular thyroid fixed to deep structures, but not to skin. Clinical diagnosis: carcinoma. No bone secondaries.

January 7, 1935.—Subtotal thyroidectomy. Tissue firm, muscles adherent. Right lobe and two-thirds of left lobe removed. Left lobe remained adherent to trachea. Histologically, Riedel's thyroiditis, Hashimoto's type.

March 13, 1935.—Increasing dysphagia and stridor. Regrowth of goitre. Left cord palsy still present. Tracheotomy. Extensive fibrosis—more characteristic of Riedel's than Hashimoto's struma.

On account of the lymphoid nature of the growth and the impossibility of further thyroidectomy, high voltage radiation was used (200 kilovolts, 0·5 mm. copper filter, 60 cm. distance). Three courses were given, one each in April, July, and October, 1935. In each course a total of 400 r was given to each of two areas, right and left sides of the thyroid region, the daily dose being 100 r alternately to one of these areas. Prompt relief of obstructive symptoms was obtained within a few days of beginning the first course. The palpable mass disappeared. The second and third courses were given for subjective symptoms of obstruction. In January, 1936, patient well, save for hypothyroidism (thyroid ration, 1½ gr. daily).

Riedel's thyroiditis may therefore be regarded by the radiotherapist as a disease of great radiosensitivity—only a very small dose is required, rapid response to simple surface application of radium being obtained without general or local reaction. This fact is of importance, not only to the patient, but also because neither complex apparatus nor large quantities of radium are necessary for efficient treatment. Such an application of radium can also be regarded as a harmless diagnostic test, since so remarkable a response could hardly be given by any other condition.

PATHOLOGY

It is generally agreed among recent observers (Ewing, 1922, 1928; Shaw and Smith, 1925; Smith and Clute, 1926; Eisen, 1924, 1936; Muir, 1936) that Riedel's thyroiditis may be defined as being characterized by lymphocytic infiltration, with or without germ-centre formation, and increasing fibrosis affecting the gland, and often adjacent structures, with alteration and atrophy of thyroid epithelium, each in varying degree: and is a pathological condition of the gland which includes the "chronic inflammation of the gland leading to the formation of an iron-hard tumour", first described by Riedel in 1896, and the somewhat similar condition, "struma lymphomatosa," described in 1912 by Hashimoto. In the former, the fibrosis is outstanding and often extensive, and there are atrophic and hyperplastic changes in many of the thyroid elements; while in the latter diffuse lymphocytic infiltration with germ-centre formation predominates, atrophic epithelial changes also occur, but extra-thyroidal fibrosis is less common. The statements by Ewing and others that these conditions are slightly different manifestations of the same

disease process have been based on studies of several cases and of the rare individual cases in which post-operative recurrence of thyroid enlargement necessitated further operative intervention (Eisen, 1934, Lit.). The related condition described by Williamson and Pearse in 1929 as " lymphadenoid goitre " we would also include as Riedel's disease, for, from the descriptions of these authors and of Joll, it seems that histologically and clinically the conditions are identical. In this we are in agreement with Muir, Means, and others.

In Riedel's thyroiditis the thyroid gland shows varying degrees of enlargement. One or both lobes are affected, and the enlargement may be local or diffuse. Thus the disease may at first appear as an adenomatous condition, which, in a period of a few or several months, extends to involve a whole lobe, the isthmus, and later the entire gland. In other cases the gland shows gradually increasing uniform enlargement from the outset. In the fully developed condition the gland may be three or four times the normal weight and on section is solid, pale yellowish white, and almost colloid-free. The gland has a characteristic iron-hardness, which is due partly to marked cellular infiltration and partly to fibrosis, which appears as broad bands of glistening tissue causing lobulation. This fibrosis, although distinct, may be limited to the gland and its capsule, thus allowing of excision with moderate ease. More commonly, however, the capsule and surrounding structures are extensively fibrosed, and removal is exceedingly difficult or even impossible, and partial excision of lobes or isthmus is practised. This extra-thyroidal fibrosis is responsible for the symptoms experienced—dyspnœa, dysphagia, and dysphonia. In extreme instances the fibrous infiltration has extended to the base of the skull (Tailhefer) and to the mediastinum (Berry, Ricard).

The larynx and trachea are often compressed, even in the absence of thyroid enlargement. Thus Riedel's third case returned, twelve years after partial thyroidectomy, without goitre but with marked dyspnœa from subglottic stenosis; and Means's case, an abstract of which is given above, required a tracheotomy only nine weeks after subtotal thyroidectomy—her first symptoms, however, had appeared ten years previously. Similar tracheal compression has been recorded by others (Silatschek, Monod, and St. George).

The disease runs a definite course and is characterized by varying histological appearances which may be studied in a series of cases or to a lesser extent in one gland. At an early stage there is an infiltration of lymphocytes. This usually increases in marked degree and is often quite extensive, and germ-centre formation usually occurs (*Figs.* 80, 81). Plasma cells are also noted and less frequently eosinophils are present. When this lymphocytic infiltration is diffuse and very extensive the epithelial elements may be almost completely replaced by round cells, and, when widespread involvement of the extraglandular tissues, especially of the muscles, also occurs, a primary diagnosis of malignancy is often made (*see Figs.* 88–90). This was the outstanding feature of *Case* 1, as it was in the third case of Shaw and Smith's series. Ewing also figures similar appearances. A lesser degree of diffuse infiltration together with prominent germ-centre formation characterizes the histology of the cases described by Hashimoto, and Williamson and Pearse.

Atrophic and hyperplastic changes occur in the parenchyma. In the earliest stages very little alteration is noted and vesicles contain normal amounts of colloid, but loss of colloid is soon apparent and all degrees of atrophy are seen (*Figs.* 80, 81).

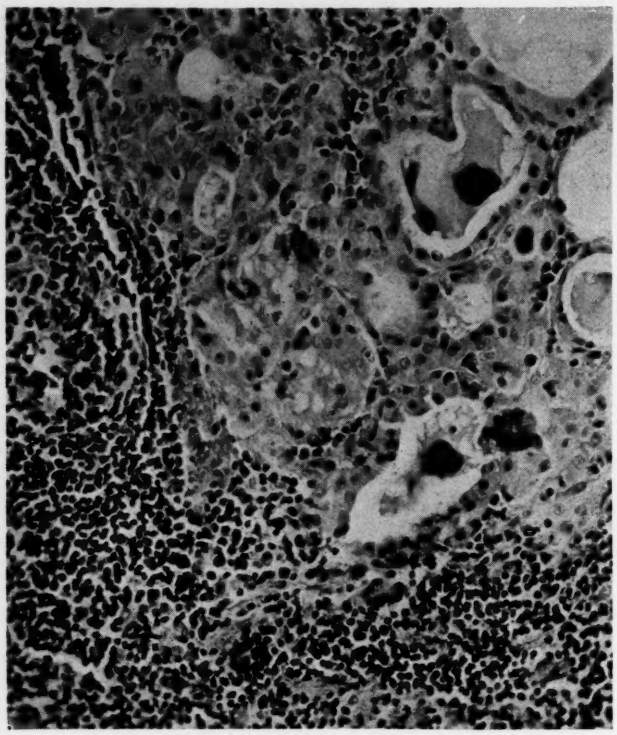

FIG. 80.—*Case* 4. Riedel's thyroiditis; earliest stage observed. Note the lymphocyte infiltration and lymphoid germ-centre formation; normal, empty, and also atrophic thyroid vesicles. (Azo-eosin and toluidin blue.) (× 200.)

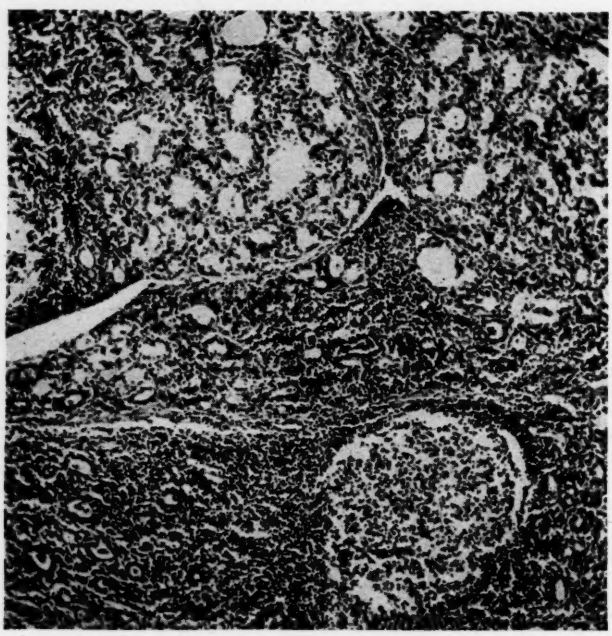

FIG. 81.—*Case* 1. Early stage. Diffuse lymphocytic infiltration with atrophy and disappearance of thyroid vesicles are the general features of this phase. A fully developed lymphoid germ-centre is seen below on the right. (Hæmalum and eosin.) (× 75.)

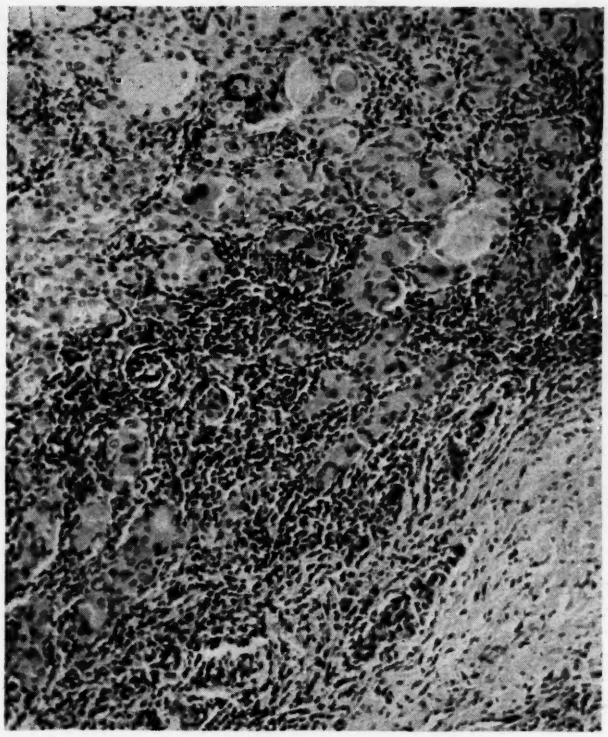

FIG. 82.—The thyroid acini in the upper part of the field show enlargement of the cell bodies with homogeneous staining and irregular size of the nuclei, some of which are hyperchromatic. There is much lymphocyte infiltration and fibrosis below. (Collection.) (Hæmalum and eosin.) (× 150.)

FIG. 83.—The margin of a nodule of altered thyroid tissue. The acini remain small, but their cells show changes similar to those in *Fig.* 82, and colloid is much reduced. (Collection.) (Hæmalum and eosin.) (× 75.)

As the disease advances the atrophic changes become more marked, and in the fully developed condition, in the densely cellular or fibrous areas, mere epithelial cords remain (*see Fig.* 87). As the vesicles become reduced in size, some of the individual cells enlarge, their protoplasm becomes more homogeneous and eosinophilic, and varying degrees of nuclear enlargement and hyperchromatism are present (*Fig.* 82). Occasionally such a change affects much of the gland. Remarkable increase in size results, and nodules of this altered thyroid tissue are formed (*Fig.* 83). In these nodules almost all the acini show enlargement of cells in some degree, and in many instances individual cell outlines are lost and a syncytium results. Colloid is very much diminished or absent. Nuclei are moderately numerous, and some are larger and more deeply staining and irregular than normal (*Fig.* 84).

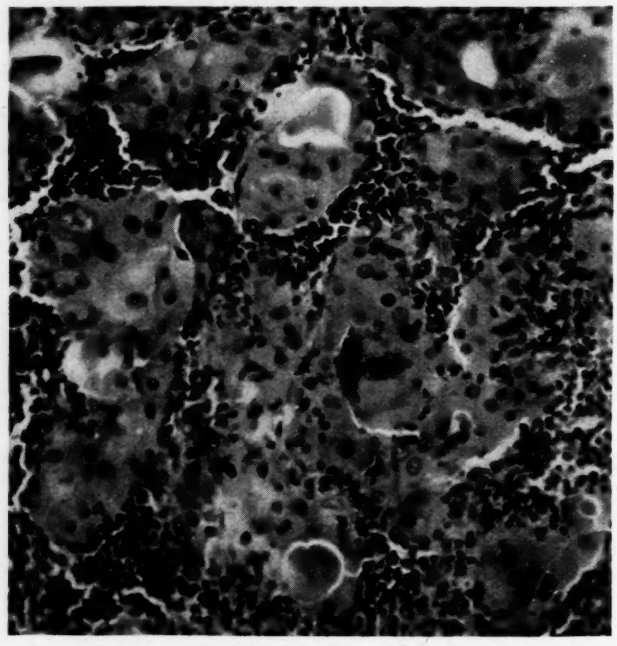

FIG. 84.—A higher power view of the altered thyroid acini, showing enlargement of cell bodies with homogeneous protoplasm. The nuclei vary in size, some being much larger than normal. (Collection.) (Hæmalum and eosin.) (× 200.)

Eisen has demonstrated abundant mitochondria in such enlarged cells and syncytial masses, and a corresponding diminution in cells becoming degenerate. When this syncytial hyperplasia is conspicuous a diagnosis of carcinoma is sometimes made at first (Shaw and Smith's sixth case; Silatschek; Balfour). Frequently hyperplastic changes and syncytial formation are slight to moderate. In such cases reduction of previous hyperplasia, or limitation of the process from the beginning, is brought about by increasing fibrosis, and all degrees of fibroblastic proliferation and of atrophy of altered epithelial elements are observed.

Fibrosis appears quite early, and aggravates the progressive epithelial loss. All stages from simple proliferation of fibroblasts to the ultimate formation of dense connective tissue throughout the gland and in the capsule are found. The degree of fibrosis is a fair measure of the stage of the disease process

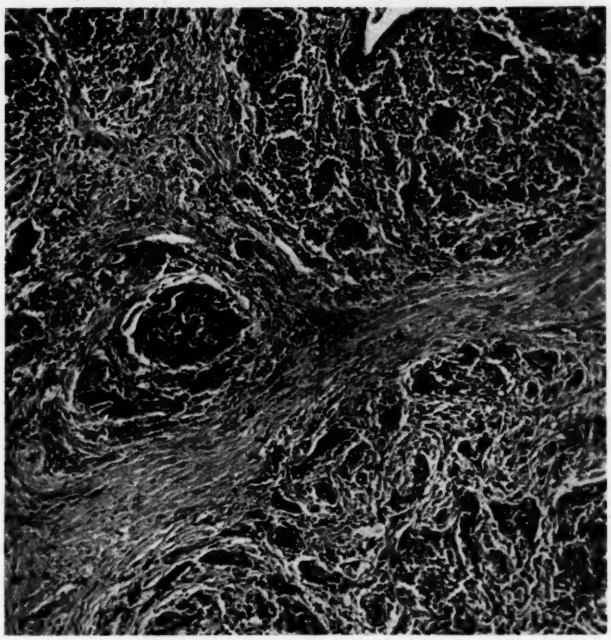

FIG. 85.—*Case* 2. There is much overgrowth of mature fibrous tissue between the lobules and a finer overgrowth of more plastic fibrous tissue invading them. The epithelial elements are much altered in type and are largely atrophic. (Hæmalum and eosin.) (× 75.)

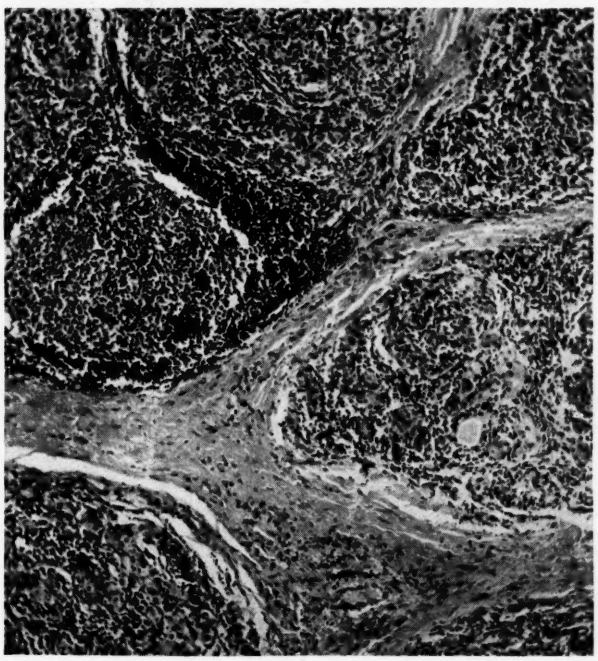

FIG. 86.—There is much coarse and fine fibrosis. The thyroid acini are almost totally atrophic and there is much lymphocytic infiltration. (Collection.) (Hæmalum and eosin.) (× 75.)

(*Figs.* 85–87). Characteristically the fibrosis extends beyond the gland and its capsule, and involves adjacent muscles (*see Fig.* 90), with loss of the normal tissue planes, almost as soon as it begins in the gland.

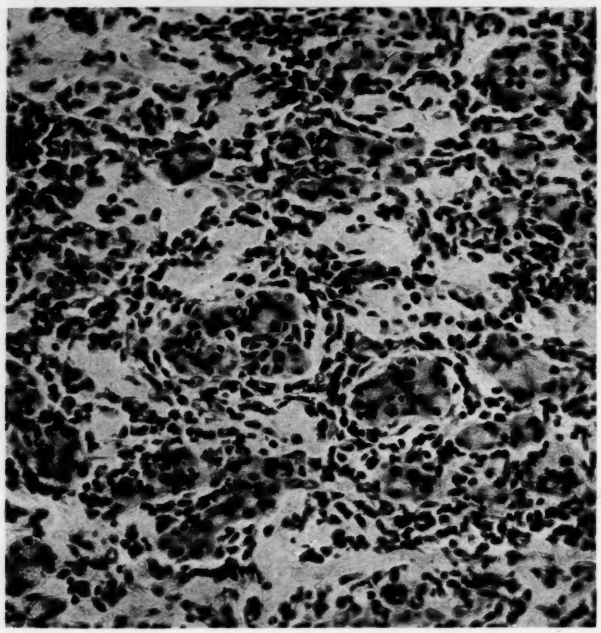

FIG. 87.—This section shows alteration and marked atrophy of thyroid acini, which are separated by pale-staining hyaline connective-tissue fibres and many lymphocytes. (Collection.) (Hæmalum and eosin.) (× 200.)

Histology of the Cases Subsequently Treated with Radium.—

Case 1.—In this case the central portion of the isthmus was removed. The main feature is the exaggerated degree of diffuse lymphocytic infiltration with occasional germ-centre formation. The general architecture of the gland is largely lost. There is great destruction of acini and a profuse cellular infiltration, the appearances of which, added to those of similar infiltration of the extracapsular tissues, including muscle, at first suggested a malignant growth. The cellular infiltration is of lymphocytes chiefly, plasma cells are sometimes noted, and the stroma is a delicate reticulum in which fibroblasts are frequent (*Fig.* 88). There is an increase of fibrous tissue throughout the gland and the capsule is ill defined, as the fibrosis extends beyond and involves the sternothyroid muscle. The latter is quite fibrosed, and the fibres show atrophy and many have disappeared. Marked infiltration of lymphoid cells is also noted outside the capsule and in the muscle (*Figs.* 89, 90). There is complete loss of thyroid epithelium in the densely cellular areas (*Fig.* 88). In other areas all degrees of atrophy to complete disappearance are noted, and only occasionally are unaffected vesicles observed (*see Fig.* 81). In such places, infrequent, relatively large germ-centres are noted. Hyperplastic epithelial changes are absent.

This case serves to add to the evidence for the essential unity of the conditions described by Riedel and by Hashimoto, for the diffuse cellular infiltration, the germ-centre formation and epithelial destruction, and the extracapsular fibrosis and infiltration are all equally developed; the former triad are more prominent on account of the diffuse nature of the changes.

Case 2.—A portion of tissue from the isthmus was available for examination. The fibrous tissue of the capsule is increased, but no extrathyroidal tissues are included in the specimen. Broad bands of mature fibrous tissue subdivide the gland and a fine diffuse fibroblastic tissue further subdivides the groups of vesicles, a peri-acinar fibrosis resulting (*see Fig.* 85). In the former areas vesicles have quite disappeared, and in the latter all degrees of

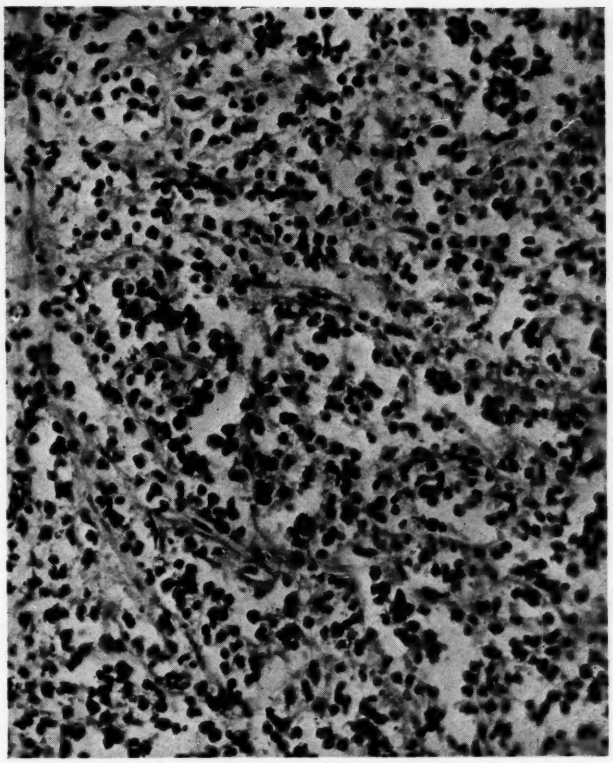

FIG. 88.—*Case* 1. The thyroid epithelium has entirely disappeared and the tissue is overrun with lymphocytes separated by delicate stroma. In such areas the appearances are sometimes suggestive of malignant growth. (Hæmalum and eosin.) (× 250.)

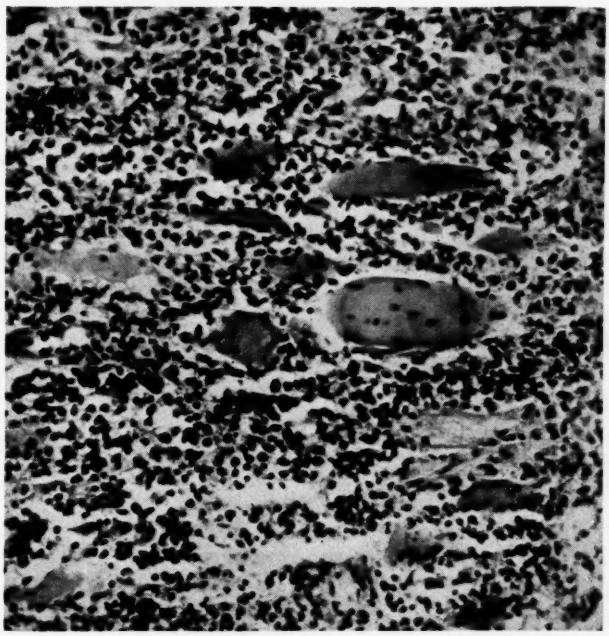

FIG. 89.—*Case* 1. The margin of sternothyroid muscle. The tissue is widely infiltrated by lymphocytes and the muscle cells show varying degrees of atrophy. (Hæmalum and eosin.) (× 200.)

disintegration and atrophy of epithelium are encountered. Most vesicles have lost their colloid and are very small and misshapen; many are represented by mere epithelial cords. Surviving acini show a moderate amount of hyperplastic change, and in the groups of such hyperchromatic and eosinophilic cells many small syncytia, which present the appearances of giant-cells, have formed. Lymphocytic infiltration is moderate in amount and is quite diffuse. There are no large focal accumulations, neither are germ-centres numerous. This is an example of a moderately advanced phase characterized by increasing fibrosis.

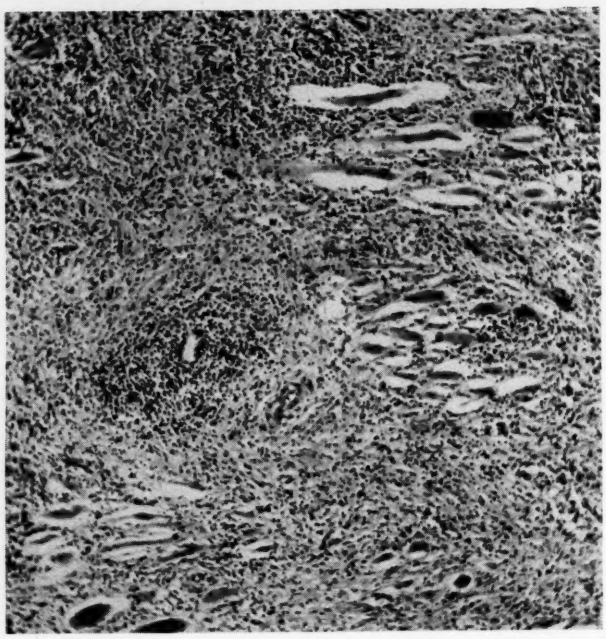

FIG. 90.—*Case* 1. The margin of excised sternothyroid muscle. The tissue has been invaded by dense fibrous overgrowth, with much lymphocytic infiltration extending from the thyroid body. The muscle fibres are scattered and atrophied. (Hæmalum and eosin.) (× 75.)

Case 4.—In this case the lesion was at an early stage and affected only a localized area in the isthmus when the biopsy was made. The patient was not subjected to a second biopsy when she returned almost two and a half years later with recurrence of symptoms; the disease affected the lateral lobes, but without much enlargement.

The general characters of thyroid tissue are preserved, and lymphocytic infiltration and germ-centre formation are quite distinct. The infiltrations are much less diffuse than in *Case* 1, and are also less dense; at the same time, however, the germ-centres are well formed, although they are smaller. There is less tendency for the cells to 'fall out' from these in sections, and they consequently appear relatively cellular. In addition, early atrophic changes are noted in the parenchyma. Several vesicles show diminution, others are devoid of colloid, while still others are very small, compressed, and already disappearing (*see Fig.* 80). In adjacent thyroid tissue these changes can be seen developing from earliest lymphocytic infiltrations. No fibrosis is present in the specimen.

Comment.—It is of interest to consider that Riedel's thyroiditis is slightly less infrequent than is commonly believed. Quite apart from the difficulty in clinical diagnosis, the histological diagnosis is not always easy. Thus, either on account of extreme lymphocytic infiltration on the one hand, or of marked syncytial hyperplasia on the other, a diagnosis of malignancy may be made in the first instance. The several instances in the literature of errors in diagnosis on each of these counts have been quoted already, and the first case in our series is an added example. In

such patients there has been spontaneous regression of the thyroid enlargement some months after operation, and they have lived to furnish further proof for periods averaging four years to the time of their being reported, but occasionally longer. No doubt there are others, unrecorded, which would increase the numbers—for example, cases considered inoperable or those 'cured'. However, as already indicated, a therapeutic test dose of radium will establish the correct diagnosis in about ten or fourteen days: if no alteration of the gland or of symptoms is noted in that time we think the condition can be regarded as truly malignant.

As regards the occurrence of lymphocytes in the gland, it has been stated by Shaw and Smith that the presence of lymphoid follicles in the gland in Riedel's disease is probably to be associated with the hyperactivity of the epithelial cells, just as it is in Graves' disease: also, the diffuse lymphocytic infiltration in the gland and surrounding structures is to be associated with the inflammatory process.

Eisen has demonstrated abundant mitochondria in the large epithelial cells and syncytial masses, and he agrees with Shaw and Smith and Smith and Clute that such are functionally overactive (hypertrophic) rather than actively growing only (hyperplastic), and together with the remaining normal acini are responsible for the absence of hypothyroidism. We are of opinion that were this so, the cases which exhibit this change prominently would show clinical evidence of a fair measure of hyperthyroidism. Eisen states that pre-operatively Riedel's disease resembles a goitre of slight activity, and in instances in which it is recorded, the pre-operative basal metabolic rate averages +10. This was also observed in four of Smith and Clute's five cases. Such evidence as we have is rather against the view that the hyperplastic cells are also hypertrophic. For example, in one case in our collection, in which the whole gland was removed surgically, the gland weighed as much as four times normal and was moderately fibrous, but showed uniform nodular hyperplasia and was relatively colloid free. The appearances of sections of this gland are seen in *Figs.* 83, 84. Despite the increase, say twice or three times the normal weight at least, of thyroid epithelium in this nodular hyperplastic gland, the small amount of remaining normal and all this abundant altered thyroid tissue were quite insufficient for normal maintenance, for the patient suffered from slight myxœdema for several weeks prior to operation. Thus we are inclined to the belief that such small degree of hyperthyroidism (B.M.R. + 10) as exists in the cases referred to by Eisen, is due possibly to the hyperactivity of normal thyroid tissue under the influence of the causal agent, rather than to any hypertrophic action of hyperplastic and syncytial elements, for, be it also noted, such are not invariably present.

Hypothyroidism is not an infrequent pre-operative feature in cases characterized by much diffuse lymphocytic infiltration ("lymphadenoid goitre" described by Joll), but a late event in untreated cases of fibrous character. However, hypothyroidism occurs in about half of the surgically treated cases of the latter group, and is, as might be expected, proportional to the amount of tissue removed and the state of the remainder (Eisen, 1936).

Riedel's thyroiditis is to be regarded as a progressive disease. Cases of spontaneous recession are rare. Ewing (1928) states that "Silatschek observed spontaneous recovery of a moderately advanced case". Recovery usually follows partial or complete removal, and favourable records show patients to be alive and well for periods of from two to seven years later—usually to the time of recording.

Of the five radium-treated cases in this series, *Case* 4 was well for a period of about two and a half years after removal of part of the isthmus. When first seen the lesion was at an early stage, but no doubt when she returned with complaint of pressure but no goitre, some fibrous changes had occurred. Moderately advanced fibrosis and moderate cellular infiltration characterized *Case* 2, and it seems reasonable to presume that similar features were present in *Cases* 3 and 5, which were not examined histologically. Of course, it is possible that *Case* 5 may have resembled *Case* 1 in showing extreme lymphocytic infiltration.

We have not been able to examine tissue from our cases since treating them, so that the post-radiation changes are largely conjectural. It seems reasonable to believe that the prompt relief of symptoms following radiation was due to the destruction of lymphocytes, and in the absence of any recurrence of enlargement it is probably correct to assume that marked lymphocytic infiltration has not recurred. Further, the absence of hypothyroidism in all would indicate that epithelial atrophy, degeneration, or alteration, too, had ceased—at least sufficient functioning glandular tissue remains so that atrophic changes, if not arrested, are minimal. Similarly the absence of pressure symptoms would suggest that the process of fibrosis has not, so far, progressed, and, if not arrested, at least the progress is slower than in the untreated disease. Time alone will provide further elucidation of this point. We are, of course, mindful of the stenosis which occurred late in Riedel's third case. Whatever it is that the radium treatment has effected, our present results are equal to those of partial resection, and in respect of the absence of hypothyroidism, superior to those of subtotal and of complete resection, quite apart from the risks attaching to operative intervention.

AETIOLOGY

The aetiology is quite unknown. We have been unable to contribute anything of a concrete nature from our cases. Tuberculosis and syphilis are no longer considered in this regard. No organisms have ever been demonstrated by the examination of operation material—in films (most writers), on culture, or on animal inoculation (Smith and Clute). Poncet and Leriche endeavoured to reproduce the disease experimentally in animals, using spirochætes, but with negative results. At first, as Muir remarks, " the changes in the thyroid rather suggest that the abnormality is primarily in the acini. A similar infiltration along with lymphoid foci as seen in the early stage, is met with in association with hyperactivity of the gland in exophthalmic goitre, and the ultimate fibrosis with atrophy of the acini resembles what is seen in myxœdema." The only difference in the gland structure, apart from extraglandular changes, in myxœdema and Riedel's thyroiditis is the cellular hyperplasia in the latter. No true association has been established between the involutional incidents occurring in the gland and Riedel's thyroiditis. While lymphocytic changes are noted routinely in the gland in exophthalmic goitre, characteristic epithelial hyperplasia of the syncytial kind is only rarely met with in our experience, and that occasionally in isolated fields ; nor can this view be reconciled with the characteristic extraglandular involvement in Riedel's struma, which Muir concludes suggests the action of some spreading irritant. Ewing, Shaw and Smith, Eisen, and others support the chronic inflammatory theory, which is based on the close resemblance which exists clinically and anatomically

between this disease and a chronic inflammatory process, as for example lymphadenoma, but with the specific features of lymphadenoma missing. Hence such terms as " ligneous thyroiditis ", " primary chronic inflammation " (Berry), and " benign granuloma " (Ewing).

In the absence of any new aspect of the aetiology of the disease, we too regard the condition as a chronic inflammatory process, but prefer to call it simply ' Riedel's thyroiditis '.

SUMMARY

Riedel's thyroiditis as we define it includes the " struma lymphomatosa " of Hashimoto and the " lymphadenoid goitre " of Williamson and Pearse.

The disease is not quite so infrequent as is commonly thought. It is progressive, and tends gradually to destroy the function of the gland. An increasing fibrosis of the gland and extraglandular structures produces pressure symptoms, dyspnœa, dysphagia, and dysphonia. In many instances it is mistaken for malignant disease.

We record the treatment of five cases by radium, in three of which, only, a small piece of tissue was removed from the isthmus for histological examination. The results have been uniformly good, and we regard the use of radium as safe, simple, and preferable to surgical treatment—and also as a specific diagnostic test.

Radium therapy is of especial benefit to the patient, as in the great majority of instances there will be no subsequent hypothyroidism, an adequate amount of functioning epithelium being left, as contrasted with the insufficient normal or hyperplastic remainder in many surgically treated cases.

The pathological features of the disease are described and discussed. The nature of the changes in the radium-treated cases is also considered.

We wish to express our thanks to Dr. Gavin Young for permission to include his case; to Dr. Loudon MacQueen, Superintendent, Western Infirmary, Glasgow, for the statistics of cases of diseases of the thyroid treated in the Infirmary during the last decade; and to Professor J. Shaw Dunn for his interest and kind help.

The photomicrographs are by one of us (J. F. H.), and the expense of the materials was defrayed from a grant from the Rankin Medical Research Fund (University of Glasgow), for which also we would express our thanks.

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ACUTE INFECTIVE OSTEOMYELITIS OF THE SPINE

By PHILIP TURNER, London

Acute osteomyelitis of the spine has been regarded as a very uncommon as well as a very fatal disease. If only the most acute cases, and especially those with serious complications, are considered, this is probably true; but if cases of less severity are included, especially those where the more accessible portions of the vertebræ are involved and where the only complication is a fairly superficial abscess, the disease is not so infrequent. The true nature of these less severe cases has often been unrecognized, and, as the majority of them recover, it is probable that the mortality is less than has been supposed. In the most acute cases the unusual character and severity of the symptoms, together with the serious nature of the complications, may mask the vertebral lesion and lead to great difficulties in diagnosis. Indeed, in the most severe and fatal cases of all, such as those in which there are symptoms of a lesion of the spinal cord, the infection of the bone may be missed altogether until the true nature of the case has been revealed at a post-mortem examination.

The above facts, combined with certain pathological characteristics, the high mortality, and the problems connected with treatment, make this disease one of great interest and importance. Osteomyelitis of the spine is now better understood and its importance as a cause of obscure suppuration is more generally recognized; hence the recent increase in the number of reported cases. As Professor Grey Turner has said in another connection, "rarities often become comparatively common when they are better understood".

Papers on osteomyelitis of the spine are still comparatively few. An excellent account has been given by Wilenski,[1] with a bibliography of earlier papers. He states that the first case was recorded by Lannelongue in 1879 and that further important early accounts were published by Hahn in 1895 and 1899. Another interesting early paper was contributed by G. H. Makins and F. G. Abbot in 1896[2]; this account was founded on 8 personal cases under the care of the authors and 13 cases collected from other sources.

In 1931 H. W. Carson[3] described 4 cases of great interest. Though these were not of the most acute type it is noteworthy that all four recovered. The full clinical notes well illustrate the obscurity of the symptoms and the difficulty of arriving at a diagnosis.

Still more recently Jacob Kulowski has published a paper on "Pyogenic Osteomyelitis of the Spine"[4, 5] based upon 102 cases, 60 of which were treated in the University Hospital, Iowa City, while 42 were investigated by questionnaire. This paper is of particular interest both on account of the large number of cases collected and the views of the author, which in some respects differ from those usually accepted. Kulowski points out that more discriminating diagnosis has resulted in a surprising increase in the frequency of the disease.

CASE REPORTS

The 12 cases on which the present paper is founded may be divided into two groups :—

1. *Cases* 1–5, in which the inflammatory process had extended to the spinal canal.

I have to thank Mr. J. Carver, Superintendent of St. Mary Abbots Hospital, for permission to publish *Case* 1, which was admitted with a provisional diagnosis of anterior poliomyelitis, under Dr. W. M. Priest, whose investigations cleared up the diagnosis in what was at first a very puzzling case. *Cases* 2 and 3 were patients in St. Luke's Hospital, Chelsea, and I have to thank Dr. E. T. Holland, the Superintendent, for permission to publish them. *Cases* 4 and 5 are from the records of Guy's Hospital.

2. *Cases* 6–12, five of which have been selected from the Guy's clinical reports —in each osteomyelitis of a vertebra was definitely diagnosed. *Case* 8 is from a museum specimen in the Gordon museum at Guy's Hospital. It was recorded by Clement Lucas in 1889,[12] and is included as it is one of the earliest cases, if not the first, to be recorded in this country.

Case 1.—Beatrice H., age 20, was admitted to St. Mary Abbots Hospital on February 9, 1935, for pyrexia, pain in the back, numbness and weakness of the legs. Dr. J. W. Tweddle, under whose care she had been, wrote as follows: "The illness commenced ten days ago with backache, pains in the legs, and fever which has persisted, but the pain in the legs has given place to some numbness. Knee-jerks are present, but slight; other reflexes are present, except the abdominal. Urine, heart, lungs, and abdomen are all normal. I am suspicious that she may be a case of anterior poliomyelitis involving a small group of muscles."

On Admission.—Temperature 103°; pulse 122; respirations 24; tongue dry and furred. There was pain and tenderness on pressure and movement in the lumbar region, but its exact localization was difficult. There was marked weakness of the left quadriceps, with pain on flexion of the hip and knee. With the exception of extension of the knee, all movements of the left leg could be performed voluntarily, but were much weaker than corresponding movements in the right leg. There was no absolute loss of sensation. The urine contained a trace of albumin and blood; a culture gave a scanty growth of *Sta. aureus*. Bilateral Kernig's sign was present and the pupils reacted normally. A lumbar puncture yielded 5 c.c. of cerebrospinal fluid, yellow in colour and under low pressure.

There was no history of any injury, but just before the onset she had several septic fingers, with suppuration of the nail-bed.

February 11.—The weakness of the left leg has increased. Attempts to flex the spine caused great pain. The knee-jerk was absent on the left side and slight on the right; abdominal reflexes present on the left, absent on the right; ankle reflexes present on both sides, with a tendency to clonus. Both ocular fundi were normal and the cranial nerves were not affected. There was nocturnal incontinence and frequency of micturition, but the urine was now normal.

Examination of the cerebrospinal fluid showed :

Protein	800 mg. per 100 c.c.
Chlorides	700 mg. per 100 c.c.
White blood-cells	41 per c.mm.
Red blood-cells	302 per c.mm.

A culture gave a growth of *Sta. aureus*.

A blood-count showed a leucocytosis of 39,100 white cells per c.mm.

A differential count showed: Polymorphs, neutrophils 78 per cent; Lymphocytes, 18 per cent; Large mononuclears, 4 per cent.

Locally tenderness was marked in both loins, especially the left, where there was œdema. Pressure on the spines from the 10th dorsal to the 2nd lumbar vertebra gave rise to severe pain.

Dr. Priest diagnosed a transverse lesion of the cord, probably due to pus or inflammatory exudation. In view of the signs it was thought that there was an acute abscess secondary to osteomyelitis of the spine.

FIRST OPERATION.—Under the anæsthetic fluctuation was easily obtained in the left lumbar region. A large abscess was opened and drained through an oblique incision just below the left 12th rib. No bare or carious bone could be felt with the finger or probe. The wound was left open and a large tube was inserted.

BACTERIOLOGICAL EXAMINATION.—A film of the pus showed the presence of Gram-positive cocci. Cultures gave a growth of *Sta. aureus*. A blood-culture was sterile and later examinations gave the same result.

PROGRESS.—Pus drained freely; but though pain was less the general condition remained unchanged; the pulse-rate varied from 120 to 130 and the temperature from 101° to 104°. There was still incontinence of urine, and the loss of power in both legs steadily increased.

March 2.—There was paralysis with loss of tone in the left quadriceps, the hamstrings, the calf muscles, and the peronei. There was a tendency to foot-drop and inversion of the

FIG. 91.—*Case* 1. Showing the condition of the left 12th rib and the vertebræ before the decompression operation.

FIG. 92.—*Case* 1. Showing the condition of the 12th dorsal and the 1st and 2nd lumbar vertebræ on March 29, 1935. The left 12th rib has been removed.

left foot. There was paresis of the right leg, but no absolute paralysis. Reflexes were still present, but the left knee-jerk was very weak. Plantar reflexes were both flexor. There was sensory loss to touch only in an area on the left leg corresponding to the 4th lumbar nerve.

X-ray Examination (March 1).—"There is osteitis with necrosis which involves the 12th dorsal and the 1st and 2nd lumbar vertebræ. The neck and costovertebral joint of the left 12th rib are destroyed. The left transverse process of the 1st lumbar is partly destroyed. Both the bodies and the laminæ are involved" (*Fig.* 91).

In view of the progressive nervous symptoms suggesting the approach of a complete paraplegia, further operation was decided upon.

SECOND OPERATION (March 6).—The abscess cavity was widely opened up. The 12th rib was loose and the proximal part of the shaft was bare, so the whole bone was removed. The spinous processes and laminæ of the 12th dorsal and the 1st lumbar vertebræ were bared of periosteum and loose, though held in position by ligaments. The left half of the lamina of the 2nd lumbar was bare, but was not loose. The loose portions were removed by grasping the spinous processes by forceps and dividing the ligamentous attachments. All sharp points and overhanging edges were then rounded off with gouge and cutting forceps. The

spinal theca, hyperæmic and covered with granulations, was exposed for 1½ in. The extradural space certainly communicated freely with the paravertebral abscess, but there was no separate extradural abscess. Both lateral surfaces of the body of the 1st dorsal were bared of periosteum and also the left side of the body of the 1st lumbar. No loose bone could be felt, and there was no interference with the vertebral bodies. The wound was washed out with saline solution and free drainage provided.

PROGRESS.—The patient slowly improved, and in about three weeks the paraplegia had cleared up. Thrombosis of the left femoral vein caused a temporary set-back. In view of the certainty of collapse of one or more vertebral bodies, she was fitted with a metal spinal support; but in spite of this, and though she was lying on her back, an angular deformity appeared within a month.

X-ray Report (March 29) (*Fig.* 92).—"Both above and below the 2nd lumbar vertebra the disc margins are uneven. The space between the 2nd and 3rd lumbar vertebræ is unduly wide. The 12th rib has been removed: there is osteomyelitis of the 12th dorsal vertebra

FIG. 93.—*Case* 1. Showing the condition in October, 1935. Notice the deformity and the new bone formation.

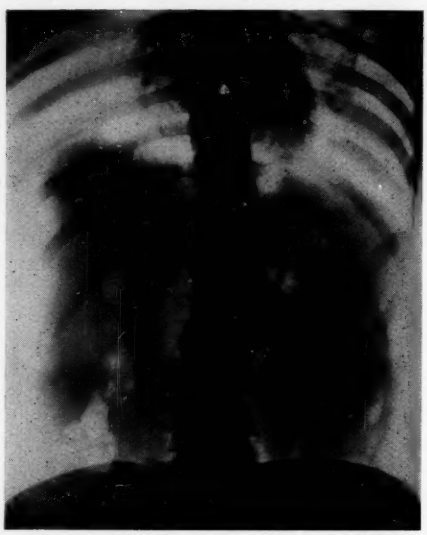

FIG. 94.—*Case* 1. Showing the condition of the vertebræ 1 year and 9 months after the operation.

the left side of the body and transverse process of the 1st lumbar are involved. The body of the 12th dorsal is wedge-shaped; irregular calcification is seen overlapping the body of the 11th dorsal. The upper part of the 2nd lumbar body is partly decalcified."

Many X-ray examinations were subsequently made: These show the gradual collapse of the body of the 12th dorsal and the ankylosis of this with the bodies of the 1st and 2nd lumbar, with the development of an angular deformity and of a lateral curve with the concavity to the right.

Suppuration continued for about three months and the pyrexia gradually subsided. Before the second operation the patient was very weak and became extremely emaciated. Afterwards she started to put on flesh and regain strength. No sequestrum was ever seen on X-ray examination; but one small spicule of bone was discharged spontaneously about three months after the operation.

The wound completely healed in August, 1935, but it opened up on two or three occasions and discharged a little pus. In November, 1935, after she had been fitted with a new spinal support, she was allowed to get up and was soon walking about the ward.

When discharged in December there was no evidence of any sensory or muscular disturbance, and no pain or tenderness in the back. There had been no increase in the spinal deformity for the past six months. An X-ray examination shortly before discharge (*Fig.* 93) showed that the affected bodies were becoming ankylosed, with hyperplasia of the bone. There were some shadows, apparently calculi, in the right kidney.

LATER HISTORY.—After leaving hospital she remained well and regained health and strength. In the summer of 1936 she had some pain in the back and a small superficial abscess containing about one drachm of pus developed about three inches below the old scar. This was drained and quickly healed. In January, 1937, an X-ray examination showed the bone to be firmly consolidated (*Fig.* 94) and she began occasionally to leave off the spinal support. It has not been entirely discarded, and in the summer of 1937 she was wearing it on alternate days. The deformity remains unchanged and there are no symptoms of any kind. The shadows in the right renal region, thought possibly to be renal calculi, have disappeared. She resumed her work as a clerk in the autumn of 1936, and has been able to carry out the duties without difficulty.

Case 2.—John T., age 17, admitted to St. Luke's Hospital, Chelsea, on October 24, 1936. Ten days before, while unloading bales from India he was stung by an insect, vaguely described as a mosquito, on the right cheek. Two days later this became painful and swollen. Five days before admission he had pain in the back which prevented him from working. Then there was dysuria with frequency and hæmaturia. About the same time he had tonsillitis.

ON ADMISSION.—Pus was oozing from a small indurated area below the right eye. Temperature 100° to 101°; pulse 80 to 90. Tonsils injected but no enlargement of glands. There was tenderness in the left renal region and also to a lesser extent in the right. Pain and tenderness in both hypochondriac regions, and also in the right lower abdominal quadrant.

There was striking loss of power in the right leg: only slight voluntary flexion of the knee was possible, and there was intense pain on attempting passive movements. The left leg was normal. The right knee-jerk was diminished; the left normal. Abdominal reflexes were present on both sides; ankle-jerks present; plantar reflexes both flexor.

October 27.—Urine contained albumin, blood, and pus; cultivation gave a growth of *Sta. aureus*. A diagnosis of perinephritic abscess or renal calculi was made provisionally.

October 29.—Pain continuous and distressing, most marked to the right of the last three lumbar vertebræ and the right sacro-iliac joint. X-ray examination "gave very little help"; nothing abnormal could be detected in the kidney, lumbar vertebræ, or sacro-iliac joint.

October 31.—Pain worse, especially over the last three lumbar vertebræ. Right leg held in position of semiflexion of the knee, with abduction and external rotation of the hip. Pyæmia was diagnosed. A second X-ray examination was negative.

November 1.—An incision was made to the right of the lumbar spine; an abscess was opened and drained; the first lumbar vertebra was bare and eroded. The condition of the patient steadily deteriorated; there was hyperpyrexia with evidence of consolidation at the left base; delirium continued, and he died on November 19.

Cultivations of the pus from the spinal abscess, the lesion on the face, and the urine all gave a growth of *Sta. aureus*. The first blood-culture was negative; later ones gave a growth of the same organism. A swab from the tonsil gave a growth of a hæmolytic streptococcus.

POST-MORTEM EXAMINATION (Sir Bernard Spilsbury).—There was an inquest, as the insect bite was received in the course of employment. Death was due to septicæmia secondary to osteomyelitis of the 1st lumbar vertebra following an insect sting. There was septic endocarditis. No record of the autopsy was available, and hence the condition of the spinal canal, the cord, and its membranes is not known.

Case 3.—Eleanor C., age 43, was admitted to St. Luke's Hospital for pain in the back and paralysis of the legs on May 25, 1936.

HISTORY.—Three weeks before she had a sore throat which lasted for a few days only. On May 18 she complained of pain in the back and ribs, which persisted until admission. On May 24 there was malaise, and on getting out of bed her legs gave way and she collapsed on the floor.

ON ADMISSION.—Temperature 102·6°; pulse-rate 104; urine normal. There was flaccid paralysis of both legs, complete of the right, incomplete of the left. Abdominal reflexes absent; both knee-jerks absent; plantar reflexes both flexor. Pain and tenderness over the lower dorsal vertebræ, but no hyperæsthesia. In the right leg sensation to pin-prick and touch were absent up to the area of the 2nd lumbar nerve; kinæsthetic sensation absent. No absolute loss of sensation in the left leg; kinæsthetic sensation diminished. Lumbar puncture produced clear, straw-coloured cerebrospinal fluid, at first under pressure (no record of chemical or bacteriological investigation available).

May 26.—Anæsthesia of right leg has extended upwards to a slight extent; now anæsthesia of left leg below the knee, with an area extending upwards on the inner side of the thigh to the gluteal region and the lower abdomen.

June 3.—Patient died. Clinical diagnosis: ascending myelitis.

POST-MORTEM EXAMINATION.—Lungs contained multiple abscesses; fibrino-purulent pleurisy over the right lower lobe; purulent infiltration of mediastinum around bodies of lower dorsal vertebræ; azygos vein contained a purulent thrombus. There was purulent osteomyelitis of the lower dorsal vertebræ (numbers not specified); pus tracking backwards beneath the erector spinæ. There was purulent pachymeningitis of the thoracic region of the theca and the lower part of the cervical region. Middle ears normal. Spleen typically septic. Kidneys showed numerous streaks of pus in the cortex.

Case 4.—Louie G., age 26, admitted to Guy's Hospital under Dr. Fawcett on February 14, 1925, for pain in the back and loss of power in the right (and only) leg.

HISTORY.—Since she was 10 years old this patient had fifteen operations for supposed tuberculous disease of various bones. The left leg had been amputated in 1915. Eight years ago she had several operations for trouble in the left forearm, and this had never quite healed.

For about a month there had been vague pains in the lumbar region, and three days before admission there was sudden acute pain in the back, followed by partial paralysis of the right leg with complete loss of sensation to a point midway between umbilicus and pubis.

ON ADMISSION.—Temperature 100°; pulse 108; pain and tenderness on pressure in the middle third of the dorsal spine; retention of urine, incontinence of fæces. Knee-jerk sluggish; abdominal reflexes absent; plantar reflex flexor. Lumbar puncture produced clear cerebrospinal fluid under pressure; this contained 0·32 per cent protein (16 times the normal), sugar also present. Wassermann reaction negative; no tubercle bacilli found. A puncture above the painful region produced normal cerebrospinal fluid containing 0·02 protein. A cisterna puncture showed that it was possible for saline solution to be passed upwards, but not downwards. An X-ray examination of the vertebral column showed no bony abnormality from the 4th dorsal downwards.

PROGRESS.—Temperature varied from 100° to 103°. Chest signs developed, especially on the left side. Further X-ray examination showed no evidence of disease in the vertebræ, but there was an opacity on the left side suggesting an empyema. Cystitis developed with pyuria and albuminuria. Anæsthesia spread to the nipple line and the level of the 7th dorsal spine. Paralysis unchanged. Patient became semi-comatose and died on March 15.

POST-MORTEM EXAMINATION.—There was a large left empyema with a thick deposit of fibrin over the back of the lung; slight thickening of one apex, but no other evidence of tubercle. Mesenteric glands calcareous. There was a large abscess adjacent to the body of the 7th dorsal vertebræ which had tracked into the pleura and also in a backward direction. The pus did not look like tuberculous pus. There was no curvature of the spine and no disease of the vertebral body; but there appeared to be an area of dead bone near the neck of the rib and in the transverse process of this vertebra. A film of the pus showed *Sta. aureus*, and a culture gave a pure growth of this organism. The theca was not involved and the spinal cord appeared normal; no inflammation of the meninges. The lower end of the left radius contained a sequestrum with pus discharging through a cloaca. There was no evidence of tuberculous disease of bone in the spine or elsewhere.

The clinical diagnosis was transverse myelitis. The case seems to have been one of chronic staphylococcal septicæmia with occasional localizations.

Case 5.—Ernest D. was admitted to Guy's Hospital under Dr. Mutch on April 18, 1927, for paralysis of both legs following a large carbuncle of the back. He was in an exceedingly grave condition and died ten days later.

POST-MORTEM EXAMINATION.—There was a large ulcerating carbuncle over the middle of the right scapula, about 4 in. in diameter, which had been incised: It infiltrated the muscles and intermuscular septa and extended to the lower ten dorsal vertebræ, the arches and spinous processes of which were bare and surrounded by thick yellow pus. The suppuration had extended to the spinal canal around the cord, outside the dura. The pia and the arachnoid were red, œdematous, and injected. The cord was compressed.

Lungs showed areas of confluent bronchopneumonia; spleen enlarged, congested, and soft. The kidneys were large and contained many round or linear abscesses.

Case 6.—Driver E., age 19, was admitted to No. 3 General Hospital, B.E.F., in June, 1917. He was gravely ill with pyrexia, rapid pulse, and acute torticollis. There was no history of injury. He had been ill for a few days with pain and stiffness in the neck and had had several rigors. The left sternomastoid was contracted, so that the chin pointed to the right. He could not move his neck, and attempts at passive movement caused severe pain. There were a number of boils on the face and neck, and though no definite enlargement of glands could be made out, the prominent upper part of the right side of the neck was very tender. He was obviously suffering from septicæmia.

An attempt was made to find and drain the pus by an incision on the right side over the site of maximum tenderness. Though the tissues beneath the fascia were œdematous no pus was found. The patient became delirious, semi-comatose, and died in 48 hours.

POST-MORTEM EXAMINATION.—There was an abscess in the sub-occipital triangle; the posterior arch of the atlas was bare, and there was pus between the periosteum and the bone. Culture of the pus gave a growth of *Sta. aureus*. The anterior arch and pedicles were normal.

Case 7.—A boy, age 12, was admitted to Guy's Hospital for pain in the upper dorsal region of one week's duration. Swelling in this region had been noticed for three or four days. No history of injury; pyrexia, but no rigors. There was a tender swelling between the shoulders from the 2nd to the 6th dorsal spinous processes.

An incision was made over the most prominent area and an abscess containing about one ounce of pus beneath the erector spinæ was opened and drained. The right side of the lamina of the 4th dorsal was felt to be bare, and a cultivation showed the presence of *Sta. aureus*. There was immediate relief and the wound healed in about three weeks, without any sequestrum coming away.

Case 8.—Museum specimen in the Gordon Museum, Guy's Hospital (Clement Lucas's case[12]): "The first two cervical vertebræ showing the posterior arch of the atlas devoid of periosteum and with a vertical line of separation between its two halves. The surrounding ligaments are disorganized and the spinal canal contains inflammatory products."

Charles R. admitted to the Evelina Hospital for pyrexia and a painful swelling at the nape of the neck of four days' duration. This was incised and two ounces of pus were evacuated. He died of pyæmia in fourteen days. At the autopsy there were abscesses in the lungs and cerebrospinal meningitis.

Case 9.—Ernest P., age 12, admitted to Guy's Hospital on September 11, 1908, for pain in the back and legs. An abscess was suspected and an incision was made over the swelling in the left lumbar region, but no pus was found; a second transverse incision just above the iliac crest also failed to find the abscess. As the symptoms persisted, a further incision was made four days later. This was internal to the first incision and was carried deeply through the erector spinæ and opened the abscess. The pus gave a growth of *Sta. aureus*.

The clinical diagnosis was osteomyelitis of a vertebra, but no mention was made in the report as to whether any sequestrum came away or whether any bare bone could be felt. No history of injury, of any skin lesion, or other source of infection.

Case 10.—Ellen B., age 2, was admitted to Guy's Hospital on September 2, 1922, for pain and swelling to the left of the spine in the lower thoracic region. Onset sudden—the child was quite well until three days before admission.

On admission there was an œdematous fluctuating swelling, with great pain and tenderness to the left of the midline in the lower thoracic region. There was a slight lateral curvature. Temperature 103·4°; pulse 136.

An incision was made over the swelling, and on passing a director through the fascia into the erector spinæ an abscess was opened. Cultivation of the pus gave a growth of *Sta. aureus*. An X-ray examination showed no disease of bone. The symptoms quickly cleared up, but a small secondary abscess in the abdominal wall had to be opened.

The clinical diagnosis was osteomyelitis of the spine, but no mention was made of bare bone being detected at the operation or of any sequestrum.

Case 11.—Ernest G., age 20, was admitted to Guy's Hospital on August 12, 1925, for a discharging sinus in the left lumbar region. Three years before the patient had "blood poisoning" with a lesion in the upper lip (probably a boil). A year later he began to have pain in the lumbar region. An abscess developed, and was opened and drained; it healed

completely and his condition improved. A year later there was osteomyelitis of the lower end of the right radius. A central abscess was opened and scraped out; the pus gave a growth of *Sta. aureus*.

In April, 1925, there was pain and swelling due to an abscess beneath the original scar in the lumbar region. Movements of the spine were good; X-ray examination showed no evidence of disease of the vertebræ. The abscess was opened and a probe passed through the great sacro-sciatic notch to the front of the sacrum.

He was again re-admitted on June 22, 1925, for another collection of pus beneath the lumbar scar. No disease of bone was seen on X-ray examination. The track was opened up and scraped out: pus gave a pure growth of *Sta. aureus*.

On August 12, 1925, he was again re-admitted for a further extensive opening up, with gouging and scraping of the anterior aspect of the sacrum. He appears to have done well after this and the wound finally healed.

Case 12.—Doris G., age 13, was admitted to St. Mary Abbots Hospital on April 14, 1937, for a large fluctuating psoas abscess on the left side which also presented in the typical way below Poupart's ligament. When aged 9 she was operated on for acute infective osteomyelitis at the upper end of the right tibia. Subsequently there was a sequestrum and a spontaneous fracture of the tibia. Pus gave a growth of *Sta. aureus*. Suppurative arthritis of the left elbow and left ankle during convalescence.

In May, 1935, abscesses were opened in the right epitrochlear region and in the right thigh. In 1936 an abscess was opened in the chest wall, just below the right scapula; also an abscess to the left of the first lumbar vertebra in the erector spinæ. No X-ray evidence of osteomyelitis of the spine; pus from all abscesses gave a growth of *Sta. aureus*.

On admission the child had lost weight and become weak and anæmic during the past four months. Temperature 101·8°; pulse 120. Scars of old operations firmly healed. Movements of spine normal; no nerve symptoms; no X-ray evidence of disease of vertebræ; urine normal. The psoas abscess was opened and a large quantity of pus evacuated; the cavity was washed out and the wound sutured. Examination of the pus showed no tubercle bacilli, but a film showed Gram-positive cocci. A culture gave a growth of *Sta. aureus*; blood-cultures negative. Though X-ray confirmation is inconclusive, there can be very little doubt that there is a small infected focus in one of the lumbar vertebræ.

AETIOLOGY

For the reasons already stated it is difficult to estimate the relative frequency of osteomyelitis of the vertebræ. Wilenski[1] found in a series of 578 cases of osteomyelitis of all bones from the records of the Mount Sinai Hospital that the spine was affected in 1·5 per cent. He also found in a series of 71 cases collected from three published series of cases of osteomyelitis of the spine that the cervical region was affected in 12, the dorsal in 19, the lumbar in 31, and the sacrum in 9. It is safe to say that the dorsal and lumbar regions are those most commonly affected.

The disease is said to be most common in the first three decades, especially the second. A history of injury is unusual, but the presence of skin lesions, such as boils (*Cases* 5, 6, 11), an insect bite (*Case* 2), septic fingers (*Case* 1), or of a sore throat is frequently noted. Occasionally there is a history of a chronic staphylococcal septicæmia with localized infections of bones at longer or shorter intervals (*Cases* 11, 12). An unusual cause is a direct extension from a superficial lesion such as a bed-sore or a carbuncle, of which *Case* 5 is an instance.

PATHOLOGY

Wilenski's account of the pathology may be summed up as follows: (1) The focus is usually of small size. In the dorsal and lumbar regions the posterior arch

and processes are commonly attacked; in the cervical region the body. (2) Usually only one vertebra is involved. (3) Generally a small and superficial area of the bone is attacked. (4) Sequestra are not constant, and when present they are usually small. (5) New bone formation (an involucrum) does not occur and is never demonstrable by X-ray examination.

Kulowski,[5] on the other hand, considers that infection usually attacks the bodies and the discs; he maintains that the disease is generally diffuse, extending from the body to the menisci and to the adjacent bodies. The X-ray appearances in *Case* 1 suggest that this was the course of events in this particular case, in which there was also a good deal of new bone formation. But in many cases the slight, or even absent, X-ray evidence of disease, often after a long interval, points to a small focus. It is probably correct to say that the focus is small and inconspicuous when laminæ and processes alone are involved, though diffuse infection is probable when the body is attacked.

In *Case* 1 it seems probable that the infection commenced in the transverse process or adjacent part of the pedicle of the 12th dorsal or the 1st lumbar. From here it extended to other parts of the same vertebra and to the adjacent menisci and bodies. This is the only case in the series where there was any sequestrum; it was only a small spicule and might well have been a chip of bone which had slipped into the abscess cavity during the operation.

The blood-supply of the vertebral body has been investigated by G. Wagoner and E. P. Pendergrass[13], who found that there were large venous sinuses forming a kind of cavernous tissue. This is drained by two pairs of veins which emerge through foramina on the antero-lateral and posterior surfaces. The circulation is sluggish, and this may account for the localization of a septic focus to a small area. The arterial supply is derived from two sources: a branch from each lumbar artery which encircles the body and gives off branches which pass directly into the bone; and the arteries which run longitudinally along the posterior surfaces of the bodies and give branches to the pedicles; and it is possible that deep blood-supply may be the explanation of the infrequency of a sequestrum when the posterior arch or processes are infected.

BACTERIOLOGY

The infecting organism is nearly always the *Staphylococcus aureus*, but occasionally other organisms, especially a hæmolytic streptococcus, have been found. In the more chronic cases similar organisms may be identified, but such cases may be difficult to distinguish clinically from tuberculous disease with secondary infection.

Balissat[15] has described three cases of actinomycosis, but these were all chronic, and two were associated with actinomycosis elsewhere.

COMPLICATIONS

1. Abscess.—Suppuration is a frequent, but not an invariable, complication. The symptoms, which are usually those of the abscess rather than the bone lesion, will depend upon the size and situation of the former.

Cervical Region.—When the body of the vertebra is affected there will probably be a retropharyngeal abscess, though the pus may track outwards along the

course of the cervical nerves and present in the posterior triangle. When a pedicle or transverse process is attacked the pus will also track outwards into the posterior triangle but when the infected focus is in the laminæ or spinous process the pus will collect beneath the deep muscles of the neck; or, in the case of the atlas or axis, into the sub-occipital triangle. Recently B. Kecht[9] has recorded two cases of osteomyelitis of the atlas, in one of which the infecting organism was *Sta. aureus* and in the other a hæmolytic streptococcus. *Cases* 6 and 8 in the present series are examples.

Dorsal Region.—Here the focus is more commonly in the laminæ or processes. Both the diagnosis and the opening of the abscess may present difficulties. When incised no bare bone may be detected, or a bare patch, usually part of the lamina, may be felt. A sequestrum is unusual and the X-ray examination negative. When the focus is in the body, the pedicle, or the front of the transverse process (*Case* 4) the pus tracks into the mediastinum, where it may burrow widely or invade the pleura or lung. There is great difficulty in making a diagnosis and most cases are fatal.

Dorso-lumbar and Lumbar Regions.—Most commonly the arch is affected, with the formation of an abscess deep to the erector spinæ. When the focus is in the body or pedicles the pus is likely to track into the loose tissue around the kidney, especially on the left side, when it simulates a perinephritic abscess, or on the right side, when it resembles a subphrenic abscess. Occasionally the pus tracks along the course of the lumbar nerves to form a psoas abscess, which may reach a large size and may be regarded as tuberculous; *Case* 12 is probably an instance of this.

The Sacrum and Coccyx.—If the posterior surface of these bones is involved, the abscess will resemble that met with in the dorsal and lumbar regions. Suppuration from a focus on the deeply placed anterior surface may present great difficulties both in diagnosis and treatment. As in *Case* 11 the pus may track backwards through the great sacro-sciatic notch and present at the back of the thigh below the glutei. If the pus travels downwards in the hollow of the sacrum it may point in the perineum near the anus, simulating an ischiorectal abscess. The difficulty in establishing the true nature of these abscesses may be very great in view of the other and commoner causes of suppuration in this region.

2. Urinary Complications.—H. W. Carson[3] called attention to the frequency of urinary infection in these cases. Each of his 4 cases had some infection of the urinary tract. In one a disorganized kidney had to be removed, and in 2 others there was acute inflammation of the prostate. In the present series, among the first 6 cases, all of which were acute and 5 of which had cord complications, 5 had evidence of infection of the urinary tract. In 3 of them the urine contained albumin and blood or pus and a culture gave a growth of *Sta. aureus*. In *Cases* 3 and 5 streaks of pus or small abscesses were found in the kidneys at the autopsy. In the remaining cases, which, though acute, had no serious complications and were quickly relieved of severe symptoms on opening and draining the abscess, no urinary infection was recorded. The matter is of considerable importance, for when the dorso-lumbar region of the spine is attacked the abscess is likely to be in the perinephritic region or in close proximity to it: the coexistence of urinary infection may then suggest the kidney as the cause, so that the bone lesion is unrecognized, at any rate in the early stages.

3. Extension of Inflammation to the Spinal Canal and Cord.—Though comparatively infrequent, this is a very important and fatal complication. Pus and inflammatory exudation lead to pressure on the spinal cord, and as the nerve symptoms overshadow those due to the bone lesion, the true nature of the case may escape recognition or only be revealed at an autopsy, as in *Cases* 3 and 4. Wilenski says that " the phenomena of bone inflammation may be lost in the maze of neurological evidence ". The clinical diagnosis may be ascending or transverse myelitis (*Cases* 3 and 4), anterior poliomyelitis (the early diagnosis in *Case* 1), or of spinal or cerebrospinal meningitis. Extension to the spinal canal may occur from a focus in the body or in the neural arch. This may be small and recognizable with difficulty (*Case* 4); or it may be extensive and involve several vertebræ. The condition varies in different cases: thus there may be inflammatory exudation and œdema of the theca and the surrounding connective tissue without actual pus (*Cases* 1 and 4); there may be an extradural abscess (*Case* 5); or the infection may have extended to the subarachnoid space, causing spinal meningitis (*Cases* 3 and 8). The condition in *Cases* 2 and 6 is unknown. The clinical symptoms vary from paralysis of a local group of muscles to a complete paraplegia, usually associated with some anæsthesia or impairment of sensation.

DIAGNOSIS

Wilenski gives the following clinical classification:—

1. Hyperacute cases with symptoms of septicæmia, such as rigors, pyrexia, delirium, and albuminuria. The general condition is very grave, and death will occur within a few days. Localizing signs may be absent, ill-defined, or overshadowed by the alarming constitutional symptoms. Septicæmia is usually diagnosed, and the local lesion is likely to be missed until revealed at an autopsy. A blood-culture will probably be positive. *Case* 6 is an example of this type of case.

2. Acute cases, but with less severe symptoms. This group is divided into the following sub-groups:—

a. There is a focus with well-marked local signs. There is clinical evidence of septicæmia, often confirmed by a blood-culture.

b. There is a definite focus with well-marked local signs of inflammation and probably an abscess. There is no clinical or bacteriological evidence of septicæmia.

c. A third sub-group may be added: This will include certain cases where there is an extension of inflammation, usually with abscess formation, to some situation where it will cause such important symptoms that the primary focus may be overshadowed and be unrecognized; or the abscess may occupy some position where suppuration from some other cause is not uncommon, and hence, though the abscess is diagnosed, its cause is overlooked.

Cases in sub-groups (*a*) and (*b*) will usually be correctly diagnosed, and though there will be some mortality, especially among the cases with septicæmia, the majority will recover.

Sub-group (*c*) will contain a considerable proportion of the unrecognized cases as well as many of the fatalities. The signs and symptoms will be those of the abscess, which is usual in acute cases. Hence a diagnosis of retropharyngeal, perinephritic, or ischiorectal abscess may be made, the cause remaining uncertain.

This is a matter of considerable importance, for if many cases are overlooked the disease will be more frequent than is usually supposed, and, as most cases recover after drainage of the abscess, the mortality will be lower. For example: Osteomyelitis in the dorso-lumbar region may result in a collection of pus in the loose tissue around the kidney. There are many other causes of an abscess in this situation, and even if the infecting organism is found to be the *Sta. aureus* it is known that a patient with staphylococcal skin lesions may develop an abscess in this situation, sometimes known as "perirenal carbuncle". But similar skin lesions may also be the source of infection in osteomyelitis of a vertebra: hence with all staphylococcal abscesses in this region, unless some other cause can be found, a focus in a vertebra should be suspected.

Much the same is true with retropharyngeal, ischiorectal, psoas, subphrenic, and other abscesses of uncertain origin.

Radiological Diagnosis.—There is a tendency to place too great reliance on a negative X-ray examination: it is, of course, usually evidence of tuberculous disease that is sought for; but nevertheless it is true that a negative X-ray report has often been the decisive reason for excluding disease of the spine.

Radiological examination is of but little use in the early diagnosis of osteomyelitis of the long bones, and of all cases of osteomyelitis the spine is least suited to a satisfactory investigation. The focus is generally small, deeply placed, beneath large muscles; intestinal contents help to obscure the view; and the lesion may be viewed through a thick layer of vertebra which is provided with processes of varying density. Sequestra are unusual and when present they are small. In the absence of destruction and collapse of a vertebral body new bone formation may be absent, and finally the attention of the radiologist is often directed to a search for evidence of tuberculous disease. It must also be pointed out that X-ray changes may not occur until much later than in the long bones. In Carson's 4 cases the interval between the onset of the disease and positive X-ray evidence was, in the first case two months; in the second, four months; in the third, fourteen months; and in the fourth, ten months. Klein[6] records 16 cases, in all of which the diagnosis was proved either at operation or autopsy: in none was there any X-ray evidence of osteomyelitis. A lesion in the spinous or transverse processes can usually be detected, while a focus in the laminæ or pedicles is generally unrecognized; a small focus in the body of a vertebra may be unrecognizable in the early stages, but some change can usually be detected if the examination is repeated at intervals, as in *Case* 12. When the bodies of one or more vertebræ are extensively affected there will be in the later stages collapse of the diseased bones, with deformity and new bone formation, as in *Case* 1.

Kulowski mentions the following conditions to which attention should be specially directed: Areas of increased density, even of small extent; bony bridges between vertebræ and localized proliferative changes; any abnormalities of the intervertebral space, however slight, are of importance. In early cases the trabecular structure of the affected area is obscured: mottling of the bone, localized destructive changes in the body, and various degrees of erosion and para-osteal calcification are occasionally seen.

Possibly with improved clinical recognition of the disease, increased attention may be directed to very slight alterations in the radiological appearance, and thus lead to earlier and more certain X-ray confirmation of the diagnosis.

MORTALITY AND PROGNOSIS

For reasons already given, the total mortality of acute osteomyelitis of the spine is not easy to estimate. The fact that many cases are undiagnosed, together with a tendency to record the most severe cases, with severe and unusual complications, makes it probable that in collected series the mortality is higher than if all cases could be included. Improved recognition of the disease also helps to explain the varying mortality in various series and also the very high mortality in the older publications. Thus Makins and Abbot[2] found a mortality of 71 per cent in 14 cases: Donati[15] a mortality of 53 per cent in 56 cases. All 4 of Carson's cases recovered, as did 4 cases recorded by Ottolenghi and Alarcon.[11] Wilenski in the Mount Sinai series of 9 cases found a mortality of 53 per cent. Probably a more accurate idea can be obtained from Kulowski's collection of 102 cases. In 10 of these there were symptoms of some lesion of the spinal cord, with a mortality of 50 per cent, while in the whole series the fatalities were just under 25 per cent.

In the hyperacute cases (group 1) death will usually occur in a few days (*Case* 6), and recovery must be very rare indeed. Among the acute cases in group 2 there will be a heavy mortality in sub-groups (*a*) and (*c*), particularly the latter. In the present series *Cases* 1–5 may be assigned to this sub-group, as they all showed cord symptoms. One recovered and 4 died—a mortality of 80 per cent. When mediastinal suppuration occurs (*Case* 4) recovery must be very uncommon, and it is possible that in some the bone lesion is not recognized even at the post-mortem.

The cases belonging to group 2, sub-group (*b*), all recovered, and it is probable that most cases of this type will do well, though the onset may be sudden and the symptoms very acute.

The prognosis is better when the focus is situated in the neural arch or the posterior aspect of the transverse process. When the lesion is in the body or on the anterior aspect of the transverse process suppuration is likely to extend to the mediastinum, the perinephric region, and the spinal canal. The abscess will be deeper, difficult to recognize and to drain, and in dangerous proximity to important structures and organs. Hence the mortality will be high.

TREATMENT

Treatment will depend upon the requirements of each individual case. An abscess should be opened and drained as soon as possible. When the focus is in the neural arch pus is usually found in the furrow external to the spinous processes, it is deeply situated beneath the erector spinæ, and a small collection may be difficult to locate (*Case* 9). On examining the cavity, bare bone may or may not be felt. In the former case the bone is left alone, unless a fragment should be loose. Even if the lamina is bare, necrosis need not necessarily occur, and then the sequestrum will generally be a small flake which will separate and come away spontaneously. The infecting organism should always be identified, and if it should prove to be the *Sta. aureus*, osteomyelitis is probably the cause.

When the anterior portion of the vertebra is involved, the abscess will be deeply situated and there may be some difficulty in localizing the pus. It has been seen that these abscesses usually occupy well-recognized situations and that the cause of the suppuration may be obscure. They are approached and treated on the usual lines. Here also bare bone may or may not be felt; but no attempt

should be made to open up or remove any bone unless some loose fragment or sequestrum should be felt. It is, however, certain that with the destruction of one or more bodies these will collapse. A single vertebra will become wedge-shaped, while if more than one is involved these will become fused into an irregular mass of bone. Thus there will be a deformity—either an angular curve or scoliosis, or both. Steps should be taken to minimize this on the lines indicated in the after-treatment of *Case* 1. When there are symptoms of a spinal cord lesion the treatment will raise difficult problems. Much will depend upon the actual condition present, and it may be stated at once that when there is spinal or cerebrospinal meningitis no surgical procedure will be of any avail; but with the other conditions that may be present a decompression operation should relieve the spinal cord symptoms, and in the absence of septicæmia or other complications, such as extension of the suppuration to some deep or inaccessible region, give a chance of recovery. It is thus necessary to diagnose not only the presence of the bone lesion but the site of the cord lesion, and especially whether this is diffuse or localized. Perhaps some idea of the relative frequency of the condition within the spinal canal may be obtained from Kulowski's series of 10 cases with cord symptoms: in 4 there was meningitis; in 4 the cord was compressed by inflammatory exudation; in 1 there was an extradural abscess; and in 1 infarction of the cord.

It would appear that a decompression has seldom been performed and that recovery is very unusual. In 2 of Kulowski's cases a laminectomy was performed; 1 died and the other (a ' questionnaire ' case) recovered. Abrahamson, McConnell, and Wilson report a case of an epidural abscess successfully treated by laminectomy, but the cause was uncertain, though it might have been secondary to a focus in one of the vertebræ. In the present series *Case* 1 recovered after a laminectomy. In none of the other four cases with cord symptoms was any decompression done, and in none of them, even if the difficulties in diagnosis had been overcome, would this have offered any prospect of success.

In *Case* 1, which recovered, the chief points in the treatment may be summed up as follows: As soon as the abscess was located it was freely opened and drained in the hope that by relieving pressure in this way, the pressure symptoms might be relieved. No diseased bone could be identified on exploration of the abscess cavity, and hence, as it seemed probable that any decompression or any interference with the bone would open up fresh channels of infection, nothing further was done. As the pressure symptoms increased, and as there was definite X-ray evidence of the site of the bone lesion, a second operation was performed about three weeks later. The affected laminæ were removed and the pressure was relieved, with rapid clearing up of the symptoms. Immediate steps were taken to minimize the certain deformity, and though one late secondary abscess had to be opened there were no sequestra which called for removal.

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INTRA-ARTERIAL GLYCERIN TREATMENT OF ELEPHANTIASIS

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ELEPHANTIASIS, although common in tropical and subtropical countries, is a condition about the aetiology of which little is known. It is true that it is associated with filariasis, and in a proportion of cases filaria embryos may be demonstrated in the blood. In elephantiasis of the lower limb the upper limit of the swelling in almost every case lies at the level of the head of the fibula. The condition is essentially a chronic lymphatic stasis with a greater or lesser degree of secondary changes in the tissues of the affected limb, but there is no known anatomical reason for the abrupt termination of the disease process at the level of the fibular head.

The treatment of elephantiasis by the intra-arterial injection of glycerin depends for its effectiveness on the power of glycerin to attract water to itself, so that when placed in contact with living tissues it causes a movement of tissue fluid from the tissue spaces towards the vessels or region in which the glycerin is placed. Because of these actions glycerin is of value in reducing the œdema associated with inflammatory states by promoting active movement of tissue fluids in the congested area.

With these known properties of glycerin in mind, it was considered worth while to attempt to ameliorate the condition of elephantiasis, especially in those cases where the secondary changes were not too far advanced. Injections of 10 per cent sterile glycerin in water were given at intervals, not less than one week apart, into the femoral artery. The optimum dose was found by experience to be 2 to 3 c.c. of the 10 per cent solution. The fluid was injected slowly through a hypodermic syringe and needle. It was more satisfactory to introduce the needle by itself into the artery and then to attach the syringe containing the solution. There was no pain or discomfort if the injection were given slowly and in a strength of 10 per cent. If larger doses than 2 to 3 c.c. were given quickly, the patient complained of some pain in the region of the knee and foot. This may be due to arterial spasm. Some female patients complained of slight abdominal pain on the following day, but it is doubtful if the pain was due to the glycerin. Four patients could not be treated by the intra-arterial method, as the artery was so difficult to enter. They were given intravenous injections instead. The results of this procedure were similar, but not so marked as in the intra-arterial series. Two patients suffering from elephantiasis were used as controls. No injections were given to them during the period of observation.

Two measurements of the affected limb were made on each day of attendance at the out-patient department. With the patient lying flat on the back on a hard table without a pillow and with legs straight and relaxed, a steel measuring tape was passed round the limb and the two measurements were taken: (*a*) maximum circumference in the region of the calf; (*b*) minimum circumference in the region of the ankle. These were found by experience to be the only measurements

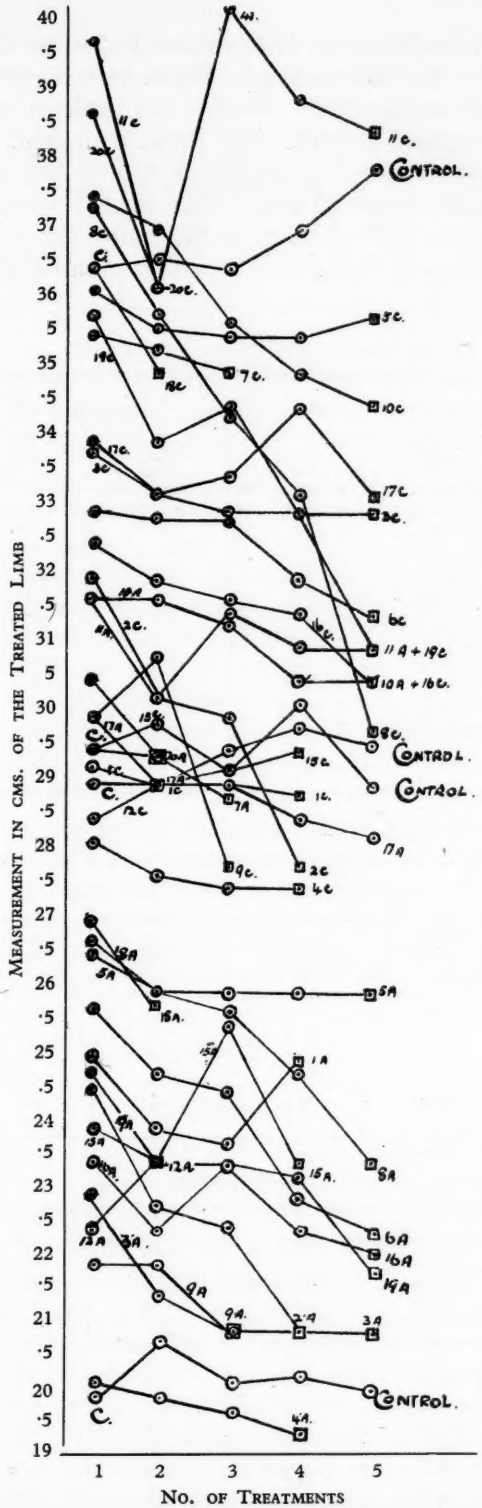

FIG 95.—The figures represent the girth of the limb in centimetres. The number of the case is given at the end of the line representing its progress of treatment. The two measurements calf and ankle are shown by the addition of the letters 'C' and 'A'.

The readings given are marked on the graph as being equally spaced out, as it is difficult to show correct spacing in days because of the irregular attendance of the patients. The actual time intervals are given in *Tables I–III*.

necessary. Attempts to estimate the limb volume had to be abandoned on account of the time required to take the readings. When both methods were used in the same cases the results corresponded closely. All patients were treated as out-patients and were encouraged to work while under treatment. None were allowed to rest in bed in hospital during treatment, as rest in bed caused of itself some diminution of the limb measurements. One of the most satisfactory results occurred in Patient 8, who walked thirty to fifty miles per week.

The results are given in *Tables I–IV* below, and are shown diagrammatically in *Fig.* 95.

Table I.—INTRA-ARTERIAL INJECTIONS

Case No.	Age	Duration of Disease	Injected Limb		Uninjected Limb		Days on which Treatment given and Measurements made
			Change in Calf Circumference	Change in Ankle Circumference	Change in Calf Circumference	Change in Ankle Circumference	
			cm.	cm.	cm.	cm.	
1	16	3 yr.	0·6	0·0	0·5	0·5	0–7–47–182
2	14	4 yr.	4·3	3·5	2·3	1·0	0–136–142–156
6	28	1 yr.	1·5	3·2	0·7	0·2	0–12–16–23–31
8	36	2 yr.	7·6	3·2	2·8	1·4	0–5–12–36–63
9	21	6 mth.	2·2	1·0	0·1	0·5	0–13–21
10	28	5 yr.	3·0	1·2	1·0	+ 0·3	0–13–47–61–109
11	24	4 yr.	1·3	0·7	1·0	+ 0·3	0–20–47–61–90
12	15	2 yr.	+ 0·5	+ 1·0	0·3	+ 0·1	0–9
15	45	2 yr.	0·0	0·5	+ 0·3	0·2	0–7–14–21
17	27	5 yr.	0·7	1·7	+ 0·3	0·0	0–8–15–22–29

Table II.—INTRAVENOUS INJECTIONS

Case No.	Age	Duration of Disease	Injected Limb		Uninjected Limb		Days on which Treatment given and Measurements made
			Change in Calf Circumference	Change in Ankle Circumference	Change in Calf Circumference	Change in Ankle Circumference	
			cm.	cm.	cm.	cm.	
4	36	3 yr.	0·6	1·7	0·0	0·0	0–7–115–131
18	38	20 yr.	1·5	1·2	0·0	0·5	0–5
19	40	2 yr.	4·8	2·8	2·1	2·8	0–10–20–28–40
20	36	6 yr.	2·5	1·1	0·2	0·3	0–7

Table III.—BILATERAL CASES

Case No.	Age	Duration of Disease	Injected Limb		Uninjected Limb		Days on which Treatment given and Measurements made
			Change in Calf Circumference	Change in Ankle Circumference	Change in Calf Circumference	Change in Ankle Circumference	
			cm.	cm.	cm.	cm.	
3	28	5 yr.	0·8	2·0	0·5	1·0	0–7–14–21–28
5	22	3 yr.	0·4	0·5	0·8	0·4	0–7–14–28–42
7	40	5 yr.	0·5	0·7	1·4	0·8	0–18–56
16	33	3 yr.	2·0	3·2	0·0	+ 1·8	0–8–15–25–31
18	38	20 yr.	1·5	1·2	0·0	0·5	0–5
19	40	2 yr.	4·8	2·8	2·1	2·8	0–10–20–28–40

Table IV.—CONTROL CASES NOT TREATED

Case No.	Age	Duration of Disease	Right Limb		Left Limb		Period of Observation
			Change in Calf Circumference	Change in Ankle Circumference	Change in Calf Circumference	Change in Ankle Circumference	
			cm.	cm.	cm.	cm.	
—	60	2 yr.	0·0	+ 0·1	+ 0·5	0·3	28 days
—	45	10 yr.	+ 1·5	+ 0·4	+ 1·2	+ 8·5	28 days

DISCUSSION

Bearing in mind the small number of cases treated, the results must be interpreted with caution. It seems reasonable to say that cases of two years' duration or less improve until the limb measurements become equal. Patients suffering from the disease between two and four years are relieved of the chronic dull aching discomfort and show a marked diminution of the limb measurements. These measurements never became normal, i.e., equal to the control (unaffected) limb. All patients were improved to some extent, and there were no complications.

A full follow-up of the patients in this country is not possible, but three people seen five months after the cessation of treatment have remained small, those less recently treated appear to be holding their own.

One patient who received a course of glycerin complained of a headache, and on examining a gland found in the axilla by the gland puncture procedure, it was discovered that the patient was suffering from trypanosomiasis as well as elephantiasis; the former is very common in the area. On receiving a course of antimony sodium tartrate, in the temporary absence of the more beneficial drug tryparsamide, it was noted that the girth of the limb further decreased in measurement. This is of interest in view of the cases reported by P. N. Das in India some years ago, which were treated for elephantiasis with antimony sodium tartrate intravenously. It would be of interest to try a further series with a combination of this drug and glycerin. It is stated that antimony sodium tartrate decreases the number of filarial embryos in the peripheral circulation.

SUMMARY

1. Intra-arterial injections of 2 to 3 c.c. of sterile 10 per cent glycerin repeated at weekly intervals afford a simple and safe method of alleviating to some extent elephantiasis of the leg due to filaria.

2. The injections are made into the femoral artery, but if for any cause this route cannot be used, intravenous injections produce an effect on the limb, though less marked.

3. The decrease in the size of the limb has been estimated by measuring the maximum calf circumference and the minimum ankle circumference.

4. Early cases show marked reduction in the size of the limb. Late cases show some improvement. The dull aching discomfort is in all cases much lessened.

5. Patients seen five months after cessation of the treatment showed limbs which either had the same size as at the end of treatment or remained smaller than before the commencement of treatment.

PLASMOCYTOMA OF THE INNOMINATE BONE

By

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ALTHOUGH plasma-cell tumours of the nasopharynx occur with comparative frequency, plasmocytoma or solitary myeloma of a bone is a rare condition. Geschickter and Copeland, writing of multiple myeloma, say that " in only five cases has the disease been found in a single focus ". Further examples, however, have been published recently. Chesterman has reported a case occurring in the tibia, and has described 12 cases from the literature in which one of the long bones was affected. Dickson Wright has described a case occurring in the body of the eighth dorsal vertebra, which was treated successfully with radon seeds. Cutler, Buschke, and Cantril have reviewed 19 cases, in 2 of which the diagnosis was doubtful, and have added 1 case of their own. The distribution of the tumours in this series was: long bones 10; vertebral column 5; skull 3; and innominate bone 2. These authors divide plasmocytomata into two groups: those that are solitary when the patient first comes under observation, but metastasize later; and those that remain localized. When metastases have occurred, and in one instance this happened after the lapse of three years, the disease runs the familiar and fatal course of multiple myelomatosis. Patients in the second group have been under observation for from four to ten years and have remained well. In the solitary type of tumour Bence-Jones protein is rarely found in the urine, but becomes a feature when the bone-marrow is diffusely involved by generalized metastases.

We have recently observed two cases in which the innominate bone has been the seat of a plasmocytoma.

CASE REPORTS

Case 1.—J. R., aged 56 years, a Welsh miner, was admitted to the Middlesex Hospital under the care of Mr. Gordon-Taylor on June 12, 1935, with a tumour of the left innominate bone, provisionally diagnosed as a sarcoma. For many years he had suffered from right-sided sciatic pain, and for the last four years he had been similarly affected on the left side. A radiograph of the pelvis was taken at the Cardiff Royal Infirmary, and this revealed a tumour of the left innominate bone. He then came under the care of Professor Sheen, who very generously referred him to Mr. Gordon-Taylor, knowing his interest in inter-innomino-abdominal amputation for tumours in this region. A biopsy was performed, and Dr. R. W. Scarff reported the section to be a typical plasmocytoma.

On admission to the Middlesex Hospital his sciatica had disappeared, but he complained of a limp and feeling of weakness in the left groin. For the last six or seven years he had found walking impossible. There was some indefinite thickening of the left ischium, and limitation of abduction and extension of the left hip-joint. A radiograph showed destruction

of the left innominate bone, involving the whole of the os pubis, part of the ischium, and part of the ilium (*Fig.* 96). The whole of the skeleton was radiographed, and there was no evidence of disease in other bones.

Other investigations carried out were :—

Wassermann reaction: Negative.

Urine : Total protein 0·005 g. per 100 c.c. No Bence-Jones protein.

Blood-count : Red blood-cells, 4,960,000 ; Hæmoglobin, 76 per cent ; White cells, 9000. There was nothing abnormal in the differential count.

TREATMENT.—In view of the microscopical appearance it was decided to try the effect of deep X-ray irradiation. The details of the technique evolved for the treatment were as follows :—

1. *Generating Condition and Absorption Data.*—Constant potential (Greinacher) circuit, kv. 190 ; ma. 6 ; half value layer, 1·45 mm. Cu ; filter, 1·0 mm. Cu, 1·0 mm. Al.

2. *Fields.*—The left pelvis was irradiated from four areas centred towards the tumour. This was done in two planes : anteriorly from within and without, and posteriorly from above and below. All fields were arranged at right angles to one another. Each field was 10 × 15

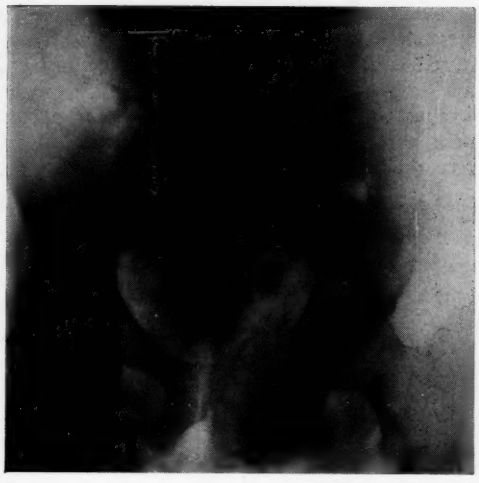

FIG. 96. — *Case* 1. Radiograph of the pelvis in June, 1935, showing extensive area of destruction of bone.

FIG. 97. — *Case* 1. Radiograph of the pelvis in August, 1936, showing increased calcification in the involved area.

cm., the surround being limited and protected by lead rubber. The surface was levelled with bolus to obtain an even back scatter.

3. *Dosage.*—The treatment was conducted four times weekly for four weeks. One area was treated at each session with 560 r w.b.s., with an average time of twenty-eight minutes, i.e., 20 r per minute.

a. Dose to skin : Dose to each area in four weeks, 2240 r w.b.s. Total dose, 8960 r w.b.s.

b. Tumour dose : The left anterior pelvic field from within, and the posterior field from below, were estimated as 10 cm. from the tumour. The left anterior pelvic field from without, and the posterior field from above, were estimated as 5 cm. from the tumour. Therefore the total dose to the tumour is estimated as 4380 r.

At the conclusion of the treatment a brisk erythema had developed, while one week later a moist desquamation with vesiculation had developed over the whole area, with concentration about and just posterior to the great trochanter. This reaction subsided in three weeks under treatment with ambrine wax, with the exception of a small area situated at the point of concentration which later necrosed.

The patient was last examined on August 20, 1936. He had no sciatica and the feeling of weakness in the left groin was much diminished. He walked with a slight limp and used a stick, but thought that he could cover four or five miles without undue effort. There was slight wasting of the left thigh, and movements of the left hip were more limited than when

he was first seen. There was moderate limitation of flexion, abduction, and adduction. Internal and external rotation were markedly diminished, and extension was non-existent. A radiograph (*Fig.* 97) showed considerable increase in calcification in the involved area. On November 12, 1937, he was reported to be in good health apart from stiffness and slight flexion deformity in the left hip.

FIG. 98.—*Case* 2. Radiograph showing tumour-formation in the ala of the right ilium.

Case 2.—G. H., aged 41 years, a labourer, sought advice at the Queen's Hospital, Birmingham, for right sacro-iliac pain, from which he had suffered for twelve months. Three months previously the pain had been aggravated by a fall from a ladder in which he had fractured the tuberosity of the right os calcis. A radiograph showed a tumour in the right ilium, and on May 11, 1937, he was admitted to hospital under the care of Mr. T. S. Donovan.

A biopsy proved the tumour to be a plasmocytoma, and on June 7 he was transferred to the General Hospital, Birmingham, for deep X-ray treatment. At this time he was walking without a limp and was free from pain, which had been relieved by the biopsy. Examination showed a diffuse swelling over

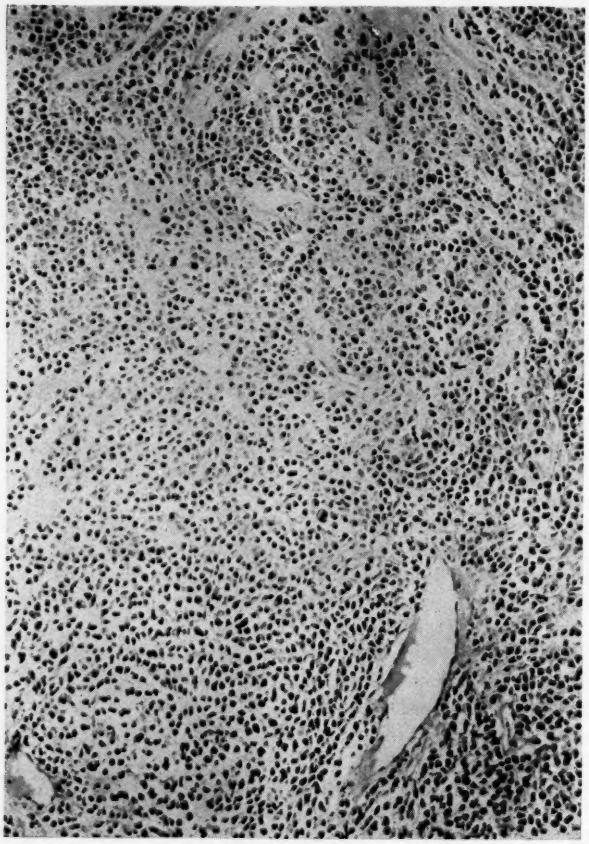

FIG. 99.—*Case* 2. Microphotograph showing plasma cells lying in a matrix of loose connective tissue.

the posterior two-thirds of the right iliac crest and the right sacro-iliac joint. A radiograph (*Fig.* 98) showed that the greater part of the ala of the right ilium, in the neighbourhood of the sacro-iliac joint, was converted into a multilocular, cystic tumour with trabeculation, which had the radiological appearances of a benign giant-cell tumour. Radiographs of the rest of the skeleton showed no abnormal changes. Bence-Jones protein was not present in the urine. The histological section showed plasma cells, many undergoing mitosis, lying in a matrix of loose connective tissue (*Fig.* 99).

FIG. 100.—*Case* 2. Radiograph taken six months after the commencement of treatment and showing some degree of calcification.

TREATMENT.—

1. *Generating Condition and Absorption Data.*—Kv. 200, constant tension; ma. 6; half value layer, 2·1 mm. Cu; filter compound, 0·4 mm. Sn, 0·25 mm. Cu, 1·0 mm. Al.

2. *Fields.*—The tumour was irradiated through two posterior fields directed obliquely inwards. Each field was 150 sq. cm. in area.

3. *Dosage.*—The treatment was given in twenty-four sessions spread over sixteen days. Each area received 3600 r to the skin, of which 2500 r reached the tumour. The total dose to the tumour is estimated in the neighbourhood of 5000 r. A well-marked, moist desquamation followed, which was slow in healing, possibly due to the impairment of the vitality of the tissues by the biopsy. In the centre of the irradiated area the desquamation proceeded to necrosis, and an ulcer developed, 1 × ½ in. in diameter. He was examined on December 14, 1937, six months after the commencement of treatment, and his general condition was good, although he still had some pain from the ulcer, which, however, was healing satisfactorily. A radiograph (*Fig.* 100) shows increased calcification, although the change from the previous picture is not very striking.

DISCUSSION

The pathology of this tumour has been carefully described by Stewart and Taylor, who find "abundant evidence of the neoplastic nature of the lesion". They find them amenable to local excision and "perhaps to radiation therapy", and therefore stress the desirability of a biopsy before submitting the patient to radical surgical treatment for what may otherwise be thought to be a highly malignant endosteal tumour. Our first case was thought to be affected with such a tumour until the diagnosis was established on a histological foundation.

A variety of methods has been invoked in the treatment, and includes deep X rays, radium, curettage, with or without bone grafting, and amputation. Although success may be predicted for the more radical measures, where they are anatomically feasible, deep X rays afford a more attractive means of treatment, especially when the alternative is an operation of the magnitude of an inter-innomino-abdominal amputation, that supreme test of the courage of surgeon and patient.

In Chesterman's series three cases were treated with deep X rays, and in only one was the result a success; but in the failures a pathological fracture was already present. In the two cases of plasmocytoma of the ilium culled from the Bone Registry of the American College of Surgeons by Cutler, Buschke, and Cantril, deep X-ray therapy was given. One was a woman of 39 with a tumour of the ala of the left ilium which resembled a giant-celled tumour radiographically, but was proved to be a plasmocytoma at biopsy; Bence-Jones protein was found in the

urine. Four months after receiving deep X-ray therapy she died of a pulmonary abscess and chronic nephritis. The other case was in a man of 58 who had been admitted to hospital with symptoms of prostatic obstruction. A radiograph of the pelvis showed a large area of diminished density with trabeculation in the right ilium, which was proved to be a plasmocytoma on section; Bence-Jones protein was not reported in the urine. X-ray therapy was given, and twenty months later the patient was well.

Of the two cases we describe one is well, apart from arthritic changes in the left hip, nearly two and a half years after the commencement of treatment; the other shows signs of improvement radiographically, and is well six months later.

From the diagnostic point of view they are interesting, as the radiograph simulates a malignant endosteal tumour in the first and a benign giant-cell tumour in the second case.

For permission to publish these cases we tender our grateful thanks to Mr. Gordon-Taylor and to Mr. T. S. Donovan.

Our thanks are also acknowledged to Dr. J. H. Douglas-Webster, who was responsible for the deep X-ray therapy in our first case, to Dr. Graham Hodgson and Dr. Harold Black for permission to publish the radiographs, and to Professor Haswell Wilson for permission to reproduce the microphotograph.

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THE NERVE TO THE EXTENSOR CARPI RADIALIS BREVIS*

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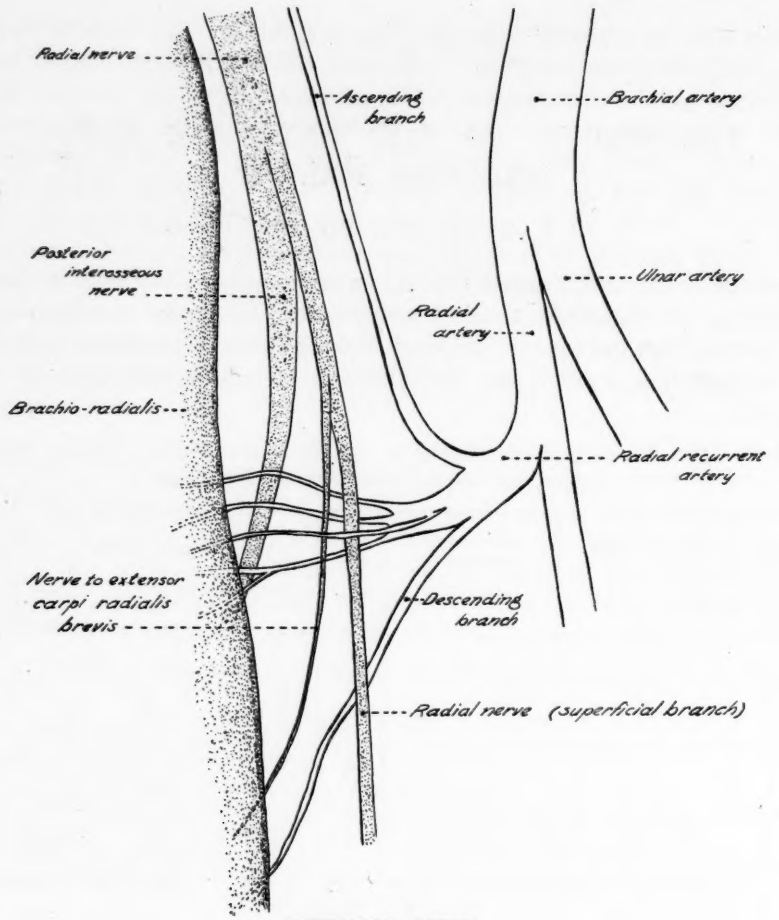
It is a universally accepted axiom that the nerve-supply to any muscle, particularly in an extremity, is of definite surgical importance. When the standard description of a nerve that is not infrequently exposed at operation can be shown to be incorrect more often than it is correct, one feels justified in calling the surgeon's attention to the error.

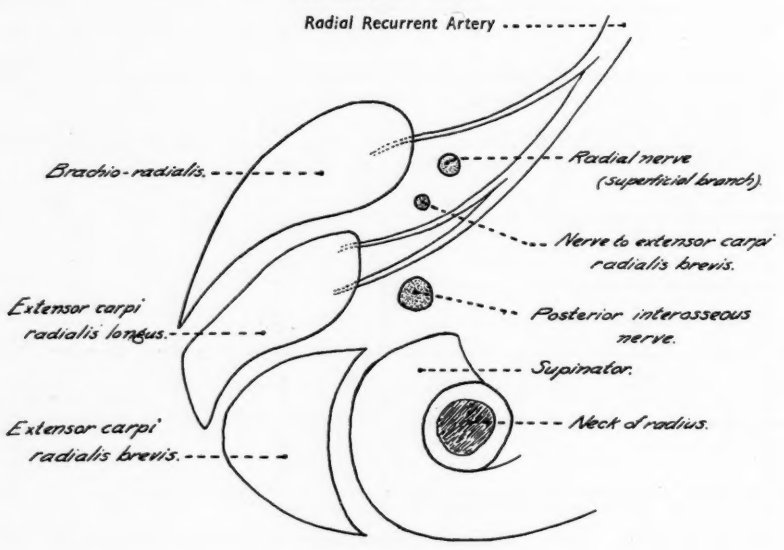
Table I.—The Source of the Nerve to the Extensor Carpi Radialis Brevis: An Analysis of 50 Consecutive Exposures

Case No.	Side	Radial Nerve	Posterior Interosseous	Case No.	Side	Radial Nerve	Posterior Interosseous
		mm.				mm.	
1	R	28		14	R		+
	L	17			L	?	?
2	R	8		15	R	4	
	L	7			L	16	
3	R		+	16	R		+
	L		+		L	21	
4	R	15		17	R	8	
	L	8			L	5	
5	R		+	18	R	9	
	L	5			L	16	
6	R		+	19	R	6	
	L		+		L		+
7	R	?	?	20	R		+
	L	7			L		+
8	R		+	21	R		+
	L		+		L	6	
9	R	?	?	22	R		+
	L	9			L	18	
10	R	?	?	23	R		+
	L	6			L		+
11	R	23		24	R	16	
	L	16			L	12	
12	R	11		25	R		+
	L		+		L	18	
13	R	23					
	L	20					

* From the Department of Anatomy, Queen's University, Kingston, Canada.



ANTERIOR VIEW



CROSS-SECTION

FIGS. 101, 102.—The relationship of the radial nerve and its branches to the radial artery and its branches In *Fig.* 101 the nerve to the extensor carpi radialis brevis is seen arising from the radial nerve.

All text-books of anatomy state that the radial nerve gives off no muscle branch distal to the posterior interosseous nerve, and that the latter is the source of the nerve to the extensor carpi radialis brevis. Having observed that this description is frequently incorrect, I have recorded the condition found in fifty consecutive forearms. The results are given in *Table I.* When a figure appears in the column headed 'Radial Nerve', it indicates that the nerve to the extensor carpi radialis brevis came from the radial that particular distance, in millimetres, distal to the origin of the posterior interosseous nerve. A '+' in the column headed 'Posterior Interosseous' shows that the muscle supply under review was from that source. A '?' denotes that the three branches separated at the same level.

Calculation from the table shows that the nerve to the extensor carpi radialis brevis was from the radial in 56 per cent, from the posterior interosseous in 36 per cent, and that in 8 per cent it came from the angle between the two and was not a branch of either.

Whatever its origin, the nerve lies directly along the posterior surface of the radial, until it enters the muscle at a point that is 6·2 to 7·5 cm. inferior to the origin of the posterior interosseous nerve. No matter how well developed the muscle may be, its antero-medial border is very thin, compressed between the extensor carpi radialis longus and the supinator, and the nerve enters the sharp edge.

The radial recurrent artery has certain almost invariable relations which facilitate the exposure of the nerve and emphasize its close association with the radial nerve. The artery is a branch of the radial, close to the origin of that vessel, or often from the brachial itself. After a course of about $\frac{1}{4}$ in., it gives off a short branch that passes almost directly laterally, superficial to the radial nerve, and enters the brachioradialis. Almost at once thereafter, the main vessel divides into an ascending branch, a descending branch, and two to four small transverse twigs. The ascending is the largest, and is the real 'recurrent' part, passing proximally between the brachioradialis and the brachialis, in company with the radial nerve. The descending part passes obliquely downward and laterally, soon joins the nerve to the extensor carpi radialis brevis, and accompanies it into the muscle. The transverse twigs pass laterally to the extensor carpi radialis longus and the deeper part of the brachioradialis. These transverse branches almost invariably pass deep to the radial nerve and the nerve to the extensor carpi radialis brevis, intervening between them and the posterior interosseous. No matter from which nerve this muscle branch arises, its relation to the vessels is the same as that of the radial. Exceptions, although occurring, are very rare. (*Figs.* 101, 102.)

The radial recurrent artery is often double. In such cases, the proximal part arises from the brachial artery and passes across the posterior surface of the biceps tendon, then turns proximally along the radial nerve to take the place of the usual ascending branch.

Cunningham's Manual of Practical Anatomy (9th ed., *Fig.* 58) shows this area very accurately, except that (*a*) the descending branch usually comes off the main trunk earlier and passes along the medial side of the nerve, and (*b*) there is always more than one transverse branch.

SUMMARY

Attention is called to an error in the standard descriptions of the nerve to the extensor carpi radialis brevis. The radial recurrent artery, not of particular importance because of its size or distribution, has very characteristic and almost constant relations to the nerve, and is described in detail.

URINARY CALCULI DEVELOPING IN RECUMBENT PATIENTS

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It has long been known that patients who undergo treatment for weeks or months in the recumbent position are liable to develop pathological conditions in the urinary tract; yet a prolonged period of recumbency is essential in the treatment of many different diseases. In medical patients it is inevitable in the treatment of many conditions; in orthopædic hospitals patients suffering from tuberculous disease of the spine or hip and from fractures of the pelvis and femur are recumbent for long periods owing to the splintage necessary for healing; in military surgery extensive war wounds of bones and soft parts, often badly infected, frequently necessitate for the patient a prolonged period of recumbency. The literature of the last few years contains a small number of references to such cases and their complications affecting the urinary tract; some authors refer to hæmaturia only, others to infection of the urinary tract, and others to calculus formation.

Recently surgeons in charge of orthopædic hospitals have come to realize some of the essential factors responsible for the prevalence of urinary calculi in recumbent patients and the measures necessary for their prevention and treatment, but the facts are still not widely understood. Moreover, although patients present themselves in urological or general surgical clinics suffering from a urinary calculus which has developed during treatment for a fracture or for bone disease, the urological literature contains very sparse and inadequate reference to the pathology, prevention, and treatment of these calculi.

We have had personal experience of a number of patients who have developed renal calculi during recumbency; the general health and recovery of these patients have been marred by complications in the urinary tract, and in 2 cases these complications have been responsible for the death of the patient. The late results —pyonephrosis and calculous anuria—are not always realized to be the disastrous end-states of a condition which is preventable, and in its early stages completely curable by medicinal and dietetic measures, leaving little or no damage to the kidneys. This paper will discuss the aetiological problems of calculi in recumbent patients so far as they are understood, and will deal with prophylactic and therapeutic measures.

LITERATURE

Lediard[1] (1875) recorded a case of stone in the bladder developing after treatment for a spinal injury; in this case the urine was heavily infected. Wilson[2] (1931) reported instances of renal colic and hæmaturia in 23 out of 150 men who suffered from fractured femur during the War; his patients were recumbent for

periods of from three to twelve months, and most had severe wounds, often infected, which were sometimes associated with ununited fractures. Hæmaturia was present in nearly every case and all had renal colic, which was sometimes bilateral; the symptoms usually occurred on the first day that the patient was allowed out of bed. One patient passed three or four friable calculi. In all but two the urine was sterile. A few patients only were X-rayed, and in these no calculi were demonstrated. Paul[3] and also Borman[4] recorded some cases of recumbency calculi developing in patients suffering from bone suppuration. Wallenstein[5] (1931) recorded a case of bilateral renal calculi, one of which was demonstrated radiographically five weeks after immobilization for a fractured spine with paraplegia for which laminectomy was performed; the urine was probably infected, as regular catheterization was carried out for a period. Mawson[6] (1932) recorded 25 cases of urolithiasis in children between the ages of 18 months and 14 years who were immobilized for tuberculosis of the spine and hip, slipped epiphysis, septic arthritis of the hip and knee, acute myelitis, spina bifida, and cœliac disease. Brown and Earlam[7] reported 6 cases of recumbency calculi; they divide calculi of this class into those which arise in association with a non-infected lesion, e.g., fractured pelvis (Cabot[8]), those arising in patients suffering from bone suppuration (Paul,[3] Borman,[4] Swift-Joly[9]), and cases arising after injury or disease of the spinal column (Müller,[10] Swift-Joly[9]). Holmes and Caplan[11] (1934) recorded cases of extensive bilateral calculus formation rapidly developing after a fractured spine with paraplegia. McCague[12] (1935) recorded 10 cases of calculi following fractured pelvis, osteomyelitis of the femur, shell injury, and fractured spine; in 4 of the cases the calculi were bilateral. Key[13] (1936) investigated complications in the urinary tract in 200 children recumbent for various orthopædic diseases; he found such complications in 32 cases, mostly children under treatment for tuberculous hips or spines: in 20 out of 32 instances calculus (renal, ureteric, or vesical) was present, pyelitis in 9, and renal tuberculosis in 3. Sisk[14] records 5 cases of recumbency calculi following fractured pelvis or spine.

MORBID ANATOMY

The calculi at first are pasty masses deposited in the calices or in the pelvis; these 'mud-stones', as they have been termed, may remain in this condition or they may solidify into true calculi. Very often by the time the calcareous deposits are of sufficient density to show on an X-ray plate they have become complete casts of one or more calices or of the entire pelvis and calices and are yellowish-white in colour; in some cases the cast is broken into two or three fragments.

If suitable treatment is instituted at an early stage, complete recovery of the patient occurs; it is highly probable, therefore, that in these cases the kidney itself suffers no permanent damage. This absence of damage to the kidney is analogous to that found in association with deposits of calcium in rats' kidneys after feeding with excess of vitamin D for short periods. In experimental feeding of rats with excess of vitamin D, one of us (L. N. P.[15]) has readily been able to induce calcification in the kidneys; the calcium is deposited first of all in the tubules of the renal cortex, but after a few days, if the hypervitaminosis is maintained, there is a shift of the calcium deposits towards the medulla and finally to the renal pelvis. Even when this occurs the kidney tissue is not damaged unless the hypervitaminosis is very intense and prolonged, when a sclerosing nephritis may follow.

Bleeding may occur from the calices or pelvis resulting from irritation by the calculous masses. If infection follows, all the changes from pyelitis to pyonephrosis and perinephric abscess may be seen, just as in the ordinary case of renal calculus seen in the surgical wards.

The calculi vary to some extent in composition, which is largely dependent upon the reaction of the urine, but all writers agree that calcium phosphates are the principal substances found in recumbency calculi; small quantities of calcium carbonate and urates are occasionally present (McCague's *Case* 1[12]). Occasionally the calcium is deposited as oxalate, and a mixed calcium-phosphate and oxalate stone results. In infected urine the stone often consists largely of triple phosphate (ammonium magnesium phosphate), and fibrin is also a constituent.

PATHOGENESIS

Calculi in recumbent patients have been attributed to bone suppuration (Paul[3]); Wilson[2] attributed the hæmaturia in his patients to vascular changes consequent on the assumption of the erect posture. Mawson,[6] in an admirable survey, stressed, among other causes, the possibility of hypervitaminosis D resulting from insolation, and thought that a lack of balance between the intake of vitamin A and the formation of vitamin D was an important aetiological factor. Urinary infection has been regarded by some authors as essential; but though frequently found, it is by no means always present.

The essential condition in the production of recumbency calculi is the establishment in the urine within the kidney of a sufficient concentration of calcium ions together with the necessary reaction to allow of the calcium being precipitated as a salt in either the larger tubules or the calices of the kidney. The processes which create this condition are varied, and no doubt several come into play in any given case. The principal aetiological factors are:—

1. Release of calcium salts from the bones into the blood-stream as a consequence of: (*a*) Generalized decalcification of the entire skeleton as a result of immobilization; (*b*) Localized decalcification of bone near the site of the injury or infection. The calcium salts so released are excreted mainly by the urine.

2. Increased concentration of calcium salts in the urine because of dehydration resulting from insolation and low intake of fluid, thus favouring precipitation.

3. Stasis and inadequate renal drainage because of the enforced recumbent posture.

4. Dietetic factors: (*a*) Influence of diet and drugs on the reaction of the urine; (*b*) Total amount of calcium taken by mouth; (*c*) Deficiency in vitamin A; (*d*) Possibly hypervitaminosis D.

5. Infection: (*a*) In the urinary tract; (*b*) Ascending urinary infection in the female; (*c*) In other parts of the body, e.g., in bone; (*d*) Constipation.

1. Release of Calcium Salts from the Bones into the Blood-stream.—

a. Generalized Decalcification of the Entire Skeleton as a Result of Immobilization.—An inspection of the radiographs of a fractured limb before and after treatment by the old method of plaster splintage without massage and movement will show that after a few weeks the bones of the limb have undergone such intense decalcification that their density (and therefore their calcium content) is very greatly reduced. Brailsford[16] has recently drawn attention to the marked rarefaction in the epiphysial

region of a long bone following immobilization. If, however, provision is made during the treatment of a fracture for movement of the muscles, the severity of the decalcification is much less marked than if no movement is possible. If the entire body is completely immobilized for a few weeks (as is necessary in the treatment of fractured spine with paraplegia, and as is often practised for fractured pelvis or femur), an enormous amount of calcium may be lost from the bony skeleton to the blood-stream to be excreted mainly by the urine.

b. Localized Decalcification of Bone near the Site of the Injury or Infection.—The evidence of radiographs can be called in to prove the still greater decalcification of bone which occurs at the site of the disease or injury. A very simple example is the decalcification of the phalanges associated with a septic finger; the diminished density, as shown by radiographs of the terminal phalanx in the presence of a felon or cellulitis of the pulp of, say, two weeks' standing, is often remarkable. That such decalcification is an active process due to increased blood-supply, is shown by the fact that, if a sequestrum forms, the dead bone ceases to decalcify, but the neighbouring living bone loses still more calcium in the succeeding days; these changes can be demonstrated in serial radiographs. Decalcification of a much greater extent can be shown in radiographs of a moderately advanced active tuberculous hip; here the upper end of the femur and bones of the acetabulum are greatly rarefied. In imperfectly mobilized fractures which are, therefore, subject to continuous small traumata, the ends of the bones often rarefy to an astonishing degree; Watson-Jones[17] has described numerous examples of decalcification in injury and infection of bone. Generally speaking the greater the degree of immobilization by splintage the greater the decalcification.

The theoretical basis of these clinical observations is largely the work of Grieg,[18] who showed that every trauma or infection of bone is followed by a reactionary local hyperæmia; his main conclusions are as follows: "Maintain the circulation within certain limits and bone remains unchanged; produce a definite hyperæmia and bone undergoes rarefaction, decalcification, osteoporosis; restrict the blood-supply and bone undergoes consolidation, increased density, osteosclerosis; cut off the blood-supply and bone undergoes necrosis."

The decalcification of immobilization is due to a relative hyperæmia of the bony skeleton. In the active healthy individual a certain balance of blood-supply is maintained as between the bony skeleton and the muscles and viscera. In the recumbent individual in whom muscular activity is greatly diminished, extensive atrophy of muscles with consequent diminution of their blood-supply often follows, so that a relative hyperæmia of bone results. The two factors of general and local decalcification combine in producing in an individual who is recumbent either from injury or disease a considerable loss of calcium from the bony skeleton into the blood-stream; the excess of calcium in the blood-stream is mainly excreted through the kidneys.

2. Dehydration Resulting in Increased Concentration of Calcium Salts in the Urine.—When large areas of the surface of the body are exposed to the hot rays of the summer sun (as is often done for therapeutic purposes to patients in orthopædic hospitals), owing to the great loss of fluid by insensible perspiration there is great danger, if the patient does not drink large quantities of fluid, that the urine will become much more concentrated than normal. There will thus be an increased tendency for salts to be thrown out of solution. This tendency to

precipitation, so far as the calcium salts are concerned, will be all the greater if increased amounts of calcium from the skeleton are being excreted through the kidneys.

3. Stasis and Inadequate Renal Drainage because of the Enforced Recumbent Posture.—In the erect posture drainage of urine from the pelvis of the kidney is assisted by the fact that its lowest point empties into the ureter, and any solid crystalline particles have therefore every chance of escaping from the pelvis into the bladder. Material from the lower calices of the kidney even in the erect posture may find some difficulty in escaping into the pelvis, as the lowest points of these calices are below the level of their channel of exit. Thus in any series of cases of renal calculi the lowest calix harbours calculi much more frequently than the middle and upper calices.

In the recumbent posture the disadvantageous position of the lowest calix with respect to drainage is shared by all the calices. The transverse axis of the kidney from without inwards occupies a plane which slopes upwards towards the middle line; this circumstance is on account of the forward projection of the vertebral column into the abdominal cavity, and its existence further accentuates the difficulty of drainage. Moreover, the line of the ureter in a recumbent patient slopes upwards from the kidney fossa to the brim of the pelvis, and this upward slope is further accentuated in those orthopædic cases which are treated by weight extension, and which therefore require the foot of the bed to be raised on blocks. These anatomical factors result in stasis and inadequate renal drainage, and favour the retention within the kidney of any solid material formed there.

4. Dietetic Factors.—

a. Influence of Diet and Drugs on the Reaction of the Urine.—As a result of the oxidation of ingested food there is a certain residue of acidic or basic ions, depending largely on the mineral content of the food taken. These ions play their part in the maintenance of the normal reaction and alkali reserve of the blood and tissue fluids. Any excess beyond what is required for the normal needs of the body is excreted in the urine. Hence the reaction of the urine depends to a considerable extent on the reaction of the oxidized mineral matter of the diet (sometimes referred to as ' ash value '). The ' ash value ' of the principal foodstuffs has been quantitatively worked out by Sherman and Gettler[19] (1912), and by reference to tables such as theirs a diet can be chosen which shall have an effect in any desired direction on the reaction of the urine. Generally speaking, a diet containing a high proportion of meat, fish, and cereals will result in the excretion of a highly acid urine, while a diet consisting wholly or mainly of vegetables and fruit will result in the excretion of an alkaline urine.

The most potent single factor favouring the precipitation of the calcium phosphates, which are the principal constituents of recumbency calculi, is an alkaline reaction of the urine; both dicalcium and tricalcium phosphate are thus precipitated, the relative amounts being dependent on the degree of alkalinity. An acid reaction keeps the calcium phosphates in solution as the soluble mono-calcium salt. Moreover, dicalcium phosphate (and probably tricalcium phosphate also, though to a less extent) which has been precipitated in the urinary tract, may be redissolved if the urine is caused to become strongly acid. If, therefore, recumbent patients receive a diet the ash of which results in the production of a non-acid urine, stone formation will be favoured, but with a diet which produces an acid urine stone

formation will be discouraged. Meat and fish, being protein-containing foods, are more expensive than vegetables and fruit, but cereals in adequate amount can easily be added to a diet to ensure a continuously acid urine.

Of the *drugs administered by mouth*, there is an unfortunate tendency for alkalis to be prescribed orally in urinary disorders without due thought of their full effect; alkalis given in this way will serve to increase the alkaline reaction of the urine and favour the precipitation of the calcium phosphates.

b. High Calcium Diet.—A diet with a high calcium content will increase the total urinary calcium and render the amount available for precipitation all the greater. Calcium in the food is mostly contained in green vegetables, milk, and cheese, but it enters in small amounts into the composition of almost every foodstuff. Normally 10 to 30 per cent of the calcium which is excreted is found in the urine and 70 to 90 per cent in the fæces (Cantarow[20]), but, as already pointed out, where decalcification of the bones occurs most of the calcium thus liberated is excreted in the urine. Moreover a high calcium diet lowers the toxicity threshold for vitamin D (Harris and Innes[21]).

c. Deficiency of Vitamin A.—With the available evidence it is not possible finally to decide if absence or deficiency of supplies of vitamin A in the body is an aetiological factor in the production of calculi in recumbent patients. The evidence so far available, however, points strongly to such deficiency being a contributory factor in the formation of renal calculi in general. It was first shown by Osborne, Mendel, and Ferry[22] (1917) that rats fed on a vitamin-A-free diet developed calculi in the bladder and kidneys, and these calculi were found upon analysis to consist of calcium phosphate with a trace of magnesium phosphate; in a few cases calcium carbonate was also present in traces. The urine of some of the animals was infected. This work has received ample confirmation and extension by the observations of Fujimaki,[23] McCarrison[24] (1926), Van Leersum[25] (1926), and Green and Mellanby[26] (1928). Green and Mellanby[26] pointed out that their rats at autopsy had widespread infective lesions in the tongue, lungs, genito-urinary tract, middle ear, prostate, spleen, and intestine.

With regard to human diet, there is general agreement that since the diet of the poorer classes in East Anglia has improved, particularly in the direction of greater supplies of protein and fats, renal calculi have become far less common. Mawson[6] points out that in many parts of the world where renal calculus is very common (in parts of India and in Europe) the diet consists largely of carbohydrate foods and is deficient in proteins and in vitamin A. In hospital, however, an adequate mixed diet is carefully provided. The usual sources of vitamin A are most green vegetables, carrots, yellow sweet potatoes, tomatoes, bananas, dates, milk, fat, and butter. In addition cod-liver oil has a high vitamin A content and is given in many hospitals to children along with malt in daily doses. Unless, therefore, the power of absorption of vitamin A by the bowel is defective in some cases, one could not attribute calculus formation in recumbent hospital patients to a deficiency of vitamin A.

A test described by Jeans and Zentmire[27] depending upon the presence of varying degrees of night-blindness, purports to show the presence of adequate or deficient supplies of vitamin A in the human body. Higgins[28] states that in a series of 16 cases of nephrolithiasis recently investigated, he has found a positive Jeans test in 11. This finding in nearly 70 per cent of cases is an important piece

of evidence, and though the presence of a similar deficiency in patients with recumbency calculi could only be discovered after the application of the Jeans test, the evidence so far available indicates that vitamin A should be given by mouth in any case in which deficiency is suspected.

d. The Possibility of Hypervitaminosis D resulting in Renal Calcification.—Pfannenstiel[29] (1927–28) first noted in rabbits the toxic reaction of irradiated ergosterol, and found that death was produced in from 15 to 40 days, and that at autopsy deposits of calcium were present in the arteries, myocardium, lungs, kidneys, and stomach. Kreitmair and Moll[30] (1928) confirmed these findings in similar experiments upon rabbits, dogs, and guinea-pigs, and there has been ample confirmation of these results by other workers. Although in animals there is an extremely wide margin between the therapeutic and toxic dose of vitamin D (Bills and Wirick,[31] 1930), in human beings Harris[32] states that the "optimum therapeutic dose appears to be not far removed from the toxic overdose, and therefore it is advisable to adhere closely to the correct dosage". The literature contains several cases of hypervitaminosis D in children and a few fatal cases which revealed the same condition of renal calcification as that seen in animals.

György[33] (1929), Hess and Lewis[34] (1928), and Klausner-Cronheim[35] (1930) observed toxic effects (vomiting, renal disturbance, hypercalcæmia) in tuberculous and rachitic children receiving doses of from 1 to 10 mg. daily of irradiated ergosterol. Putscher[36] (1929) and Thatcher[37] (1931) recorded fatal cases with renal calcification. Thatcher[38] (1936) has recently recorded a further case of a baby 11½ months old who died after a period of failing health for four months; the only cause of death found at autopsy was calcification in the kidneys resembling exactly the changes found in fatal cases of hypervitaminosis D previously reported in animals.

The evidence seems, therefore, conclusive that renal calcification can be produced in human beings by overfeeding with large doses of vitamin D, or even, in the case of infants, by overfeeding with large doses of cod-liver oil. The question also arises as to whether children may have an idiosyncrasy to vitamin D, which may result in pathological changes following a dosage usually producing no ill-effect. The reported cases in humans are, however, so very rare, and the effects of overdosage so well known, that it is unlikely that in hospitals where large numbers of tuberculous children are treated for bone conditions over-feeding with vitamin D will occur. At the same time it is clearly important to understand the possible ill-effects that can arise.

We are on more difficult ground when we come to the question of the possible *over-production of vitamin D by insolation.* Vitamin D is synthesized in the skin by the action of ultra-violet light; pigmentation constitutes the natural defence mechanism of the body against its overproduction by the action of the sun's rays. Any marked excess of vitamin D in the body would result in an elevation of the serum calcium. Mawson[6] (1932) examined the serum-calcium in 25 patients of ages between 1½ and 14, suffering mostly from tuberculous disease of the hip or spine, in whom renal calculi had developed during recumbency; all the patients had had treatment by insolation. The serum-calcium figures (except in 2 cases) varied between 11 and 13·04 mg. per 100 c.c. blood. Five control cases examined immediately after admission to hospital suffering from tuberculous disease of the hips or spine, gave readings constantly between 9 and 11 mg. per 100 c.c. of blood

(normal). These figures appear at first sight to favour the theory of production of hypervitaminosis D by the sun's rays. Mawson[6] (1932) also recorded increased calcium excretion in the urine, which commonly accompanies hypervitaminosis D as well as other states of hypercalcæmia (e.g., hyperparathyroidism). She suggests, therefore, that the excessive irradiation by the sun's rays is a factor in the production of renal calcification in recumbent patients. Hoyle[39] (1929) suggested that prolonged exposure to the sun in tropical climates may be a cause of stone in the kidney.

Serum-calcium estimations were made by us in a short series of cases of renal calculi in recumbent orthopædic cases at Oswestry and upon a similar number of controls. The figures are tabulated below, and they show no essential difference between the cases with or without stone; these figures support Harris's view that pigmentation of the skin is a sufficient defence against hypervitaminosis D resulting from the action of the sun's rays.

Table I.—Serum-calcium Estimations in Recumbent Orthopædic Cases with Renal Calculi

Name	Age	Disease	Length of time Recumbent	Serum-calcium	Plasma-phosphorus	Blood-phosphatase (Jenner and Kay's Method)
	Yr.		mth.	mg.	mg.	units
A. W.	19	Tuberculous spine	6	10·8	3·0	1·9
A. D.	20	Chronic infective arthritis	22	10·3	3·2	5·4
L. W.	18	Tuberculous hip	17	10·4	3·2	6·2
M. W.	5½	Tuberculous hip	24	10·7	3·9	5·8
G. R.	33	Chronic infective arthritis	24	10·5	1·95	5·2
R. H.	13	Septic arthritis of left hip	17	9·6	3·75	6·2

Note. All the above cases had stones in the kidneys. Six control estimations of the serum-calcium in patients recumbent for the treatment of chronic bone disease, but *without renal calculi*, gave figures constantly between 9 and 11 mg. per 100 c.c. blood.

In the Oswestry cases of renal calculus tabulated above, the urine was either aseptic or only very mildly infected. Some of Mawson's cases showed gross pyuria and possibly suffered from definite renal insufficiency, though complete details are not given. Under such circumstances we believe that hyperplasia of the parathyroids sometimes results, and that this may be responsible for the elevation of the serum-calcium which she found. The evidence upon which this contention is based has recently been published (Fowweather and Pyrah,[42] 1938).

The hypothesis, therefore, that recumbency calculi may be in part produced by insolation and consequent hypervitaminosis D, though attractive, is not, we consider, proved, and we believe that the weight of the evidence is against it.

5. Infection.—

a. The Urinary Tract.—It is doubtful if infection of the urine is an *essential* factor in the formation of recumbency calculi. One of our cases is that of a man suffering from tuberculosis of the spine and also showing large bilateral renal calculi; a catheter specimen of urine contained no pus and on culture was sterile. Another case suffered from bilateral renal calculi which developed during treatment for arthritis of the hip; no organisms were found in the urine upon repeated examination.

We consider, however, that infection in the urinary tract may sometimes be

the determining factor in stone formation, and is very often the major factor responsible for the *persistence* of the calculi; infection results in the deposition of organic debris and of fibrin upon the mucous surfaces, from which they may become incorporated in calculous material and serve as a cement, binding the particles together and probably protecting them from solution when conditions might be otherwise favourable to such a process.

Infection of the urinary tract does, however, very often complicate recumbency calculi, as some of the cases in our series have shown; the infection may be introduced into the bladder during the urethral instrumentation often carried out in cases of fractured spine with paraplegia and retention of urine.

b. Ascending Urinary Infection in the Female.—In female patients with plaster spicas, lack of cleanliness of the vulval and anal regions may result in an ascending infection of the urinary tract.

c. Infection of Bone.—A focus of infection in a bone may be the primary origin of a urinary infection, the organism being transmitted by the blood-stream.

d. Constipation, exacerbated by loss of tone of the abdominal muscles during recumbency, may be responsible for urinary infection.

SYMPTOMATOLOGY

Most recorded cases have been found to have developed renal calculi after many months or years of recumbency. Key[13] (1936) recorded one case which developed a calculus after only seven weeks of recumbency. There are good theoretical reasons for supposing that their development actually commences early in recumbency, and it is probably true that if a stone does not develop early it will not develop at all. The stones grow by accretion because of the persistence of the cause. It is very likely that if suitable investigations were made, either actual or circumstantial proof of their existence would be found very soon after recumbency had begun.

The first symptom is usually hæmaturia, and it occurs soon after the patient has been turned from the dorsal position to the ventral; the hæmaturia is often profuse. Renal colic occurs in a considerable number with or without bleeding, though red blood-corpuscles will usually be found if the urine is examined microscopically although gross hæmorrhage is absent. The presence of either colic or hæmaturia in recumbent patients usually indicates that a calculus is present.

In some cases temperature associated with rigors and renal aching have been the first symptoms; the case has then presented the picture of acute pyelitis rather than that of a stone, as in one case in our series. A radiograph will reveal the correct diagnosis. The amount of pus in the urine is usually small unless pyonephrosis has supervened.

In a few cases the patient may have had few renal symptoms at the time of his recumbency, and these may have been entirely in abeyance until at a later date—months or even years afterwards—the patient may be admitted to a general hospital with renal calculus or its complications. In such circumstances the urine is nearly always infected and a chronic pyonephrosis may be found; alternatively, the patient may have bilateral calculi and one ureter may have become blocked by a migrating stone, with a resulting calculous anuria. Either of these complications may of course develop during recumbency.

TREATMENT

1. Prevention.—The aim for the future must be the prevention of calculus formation and of urinary infection. A routine must be evolved for the care of all recumbent patients so that the development of calculi will be impossible. Our knowledge is as yet incomplete, but recent contributions make it likely that in the near future complete prophylaxis will be attained. The treatment of recumbency calculi owes much to Pugh,[40] who has laid down the principles of prevention. Each possible aetiological factor must be neutralized, and the following are the measures to be adopted :—

a. Decalcification of bone, dependent as it is upon a relative hyperæmia, cannot be absolutely prevented, but it can be minimized by routine daily massage and active movements to the limbs not actually splinted ; this will secure that a larger proportion of their normal blood-supply will be retained in the muscles by preventing muscular wasting.

b. Large amounts of fluid must be supplied to the patients at regular intervals throughout the day. The fluid should either be neutral in reaction (such as water) or should be such that any ' ash ' from the solid residue should be acid in reaction. Lemon-water after oxidation leaves an alkaline ash and is therefore not suitable, but barley-water leaves an acid ash and is therefore to be preferred. At least half a pint of fluid should be taken with meals and a further half pint between meals and first thing in the morning. In order to minimize fluid loss from the surface of the body, exposure of the body to the sun's rays in the hottest part of the day should be avoided.

c. In order that stasis of urine containing solid particles should not occur in the renal pelvis, the recumbent patient should be turned, either by tilting him to one side, or by turning him into the prone position, at fairly frequent and regular intervals. If the patient is turned into the prone position, suitable modification of plaster casts are needed, and turning should take place every three or four days. Pugh[40] has designed special frames for the use of patients with tuberculous hips and spines which can be tilted so that the patient can be rotated first to one side and then to the other for a given period each day and so that the head-end can be elevated. In this way the gravitational effects of recumbency as regards calculus formation are overcome, and intermittent drainage from calices to pelvis and ureter is provided for. Pugh claims that by this method and by avoiding dehydration he can reduce the incidence of calculus formation to a minimum.

d. In order to render the urine acid and thus maintain solution of the urinary calcium phosphate, a diet yielding an acid ' ash ' should be adopted as a routine ; there is no need to aim at a high degree of acidity.

e. Vitamin A should be prescribed, though its position as an aetiological agent is not yet finally established. Higgins[28] uses capsules of carotene in oil. Excess of vitamin D in any of its various preparations by mouth should be carefully avoided ; probably it is best administered as cod-liver oil.

f. Constipation should be avoided, by the use of aperients if necessary. Absolute cleanliness, particularly of the vulval and anal region of females in plaster, is vital if ascending infection is to be prevented.

g. Prophylactic examination of the urine for red blood-cells should be made once monthly, and their presence should be taken to indicate the necessity for active therapeutic measures against a possible calculus.

2. Treatment of Non-infected or Slightly Infected Calculi.—The object of treatment is to cause the renal calculi to go into solution or to disintegrate into tiny particles so that these will pass down the ureter and be excreted. If the urine is non-infected, operation is contra-indicated, as the stone can usually be made to disappear. The disappearance should be controlled by serial radiography, but appropriate treatment should be maintained for a considerable time after the last disappearance of the shadows from the radiograph, as small calculi may not give a shadow. In renal calculi associated with a minimal infection in the urine, conservative measures are worth trying, though if they fail resort may have to be made to operation at a later date.

All the measures which have been outlined in the previous paragraph for the prevention of calculi should be intensified. The production by diet of an acid urine of *p*H 4·8 to 5·3 should be aimed at, as this appears to be most favourable for ensuring solution of the calcium phosphates. Details of the diet are given below. There is usually no difficulty in producing the required acidity of the urine, but should the *p*H not be lowered sufficiently, the addition of 7 to 10 gr. of ammonium chloride given in capsules every four hours will lower the *p*H to the level required. One of our cases was an example of very rapid solution of bilateral aseptic renal calculi. Before undergoing treatment he was known to have had the stones for three years. The treatment outlined above was put in hand and he immediately began to pass pieces of grit in every specimen of urine, often accompanied by small amounts of blood; this went on for eight weeks, when it was noticed that no more grit was passed and a radiograph then showed that both the stones had disappeared. Wesson[41] (1936) records a case of malunion after a fracture of the femur in a girl of 14 who underwent several operations culminating in a successful bone-graft and bone-lengthening operation; during recumbency she developed large stones in both kidneys, without any evidence of urinary infection. The combined use of ammonium chloride and an acid-ash diet reduced the urinary *p*H to a level between 4·8 and 5·2 and the stones disappeared.

Many stones have been made to disappear by the combined use of active movements, hydrotherapy, avoidance of excess of exposure to the sun, and turning the patient. The addition of the acid-ash diet, however, is a rational means of increasing the rate of disappearance of the stones, and in our experience has proved extremely valuable. Operation for removal of stone in non-infected cases would only be indicated in the presence of severe and intractable pain or calculous anuria.

ACIDOGENIC DIET

Breakfast	..	Cereal or porridge, sugar, cream. Eggs, boiled, poached, or fried. Bacon, kidney, cold ham, fish. Bread and butter.
Lunch	..	Beef, mutton, chicken, ham, liver, lean pork, veal, omelette, rice, macaroni, lentils, spaghetti. Stewed plums, stewed prunes, cream. Cheese and biscuits.
Tea	..	Weak tea, sugar, milk or cream. Toast with butter. Egg sandwiches, sardine sandwiches.
Supper	..	Meat as for lunch. Fish (salmon, mackerel, herring, halibut, haddock), bread and butter, weak tea or small amount of coffee.

3. Treatment of Grossly Infected Calculi.—Calculi associated with gross infection of the urine require surgical intervention for their removal. The measures outlined above are not, generally speaking, efficacious. Calculous pyonephrosis and calculous anuria form absolute indications for surgery; the last-named condition is, of course, one of great urgency, and occurred in one case in our series.

CASE REPORTS

Case 1.—G. B., age 20.

HISTORY.—In August, 1933, the patient complained of inability to play games and of a sensation of weakness in the back. In November, 1933, he developed kyphosis, and a month later he developed muscular weakness of the legs. In January, 1934, he was admitted to Leeds General Infirmary, where Pott's disease affecting the eleventh and twelfth dorsal vertebræ

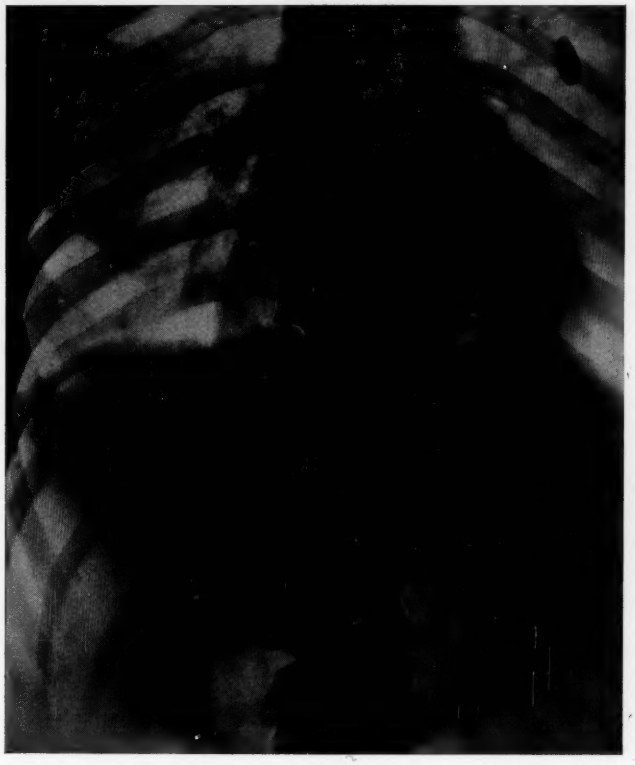

FIG. 103.—*Case* 1. Radiograph showing bilatera renal calculi. These calculi completely disappeared on the treatment described in the paper, after having been known to be present for three years.

was diagnosed and he was placed upon a Bradford frame; shortly afterwards all power of the legs was lost and there was some loss of sensation. In September, 1934, the patient was placed in a plaster bed. In October, 1935, laminectomy and bone-grafting were performed, after which the power of the lower limbs gradually began to return. Shortly after the operation (October, 1935) the patient had hæmaturia for two weeks, and a subsequent radiograph revealed large bilateral renal calculi (*Fig.* 103). The patient was first seen by one of us in May, 1937. A further radiograph showed the calculi to be as large as in 1935. The urine was sterile and contained no pus after two separate examinations.

TREATMENT.—He was placed upon an acid-ash diet with a high vitamin A content. As he was now fit to get up he was allowed to walk about wearing a spinal support. Immediately he commenced to pass tiny portions of grit in the urine, many specimens of which were tinged with blood; this state of affairs lasted eight weeks. A radiograph then showed that the renal calculi had completely disappeared and had evidently partly gone into solution and partly been passed as grit.

Case 2.—A. J. H. male, age 33.

HISTORY.—In the autumn of 1936 the patient developed osteo-arthritis of the right hip-joint and was sent to a convalescent hospital in the country in January, 1937, where he was treated in plaster spicas. In March, 1937, the patient had renal colic with hæmaturia.

He was investigated by one of us in June, 1937. The urine was found to be sterile; it contained numbers of red blood-corpuscles but no pus cells. The blood urea-nitrogen was 23·4 mg. per 100 c.c. blood. The serum-calcium was 11·5 mg. per 100 c.c. Radiography showed large masses of calculi in the right kidney and a number of smaller ones in the left. Cystoscopy showed the bladder to be normal; both ureteric orifices secreted indigo-carmine after four minutes in good concentration. On going into the question of his diet during his stay at the convalescent hospital we found that he had been placed upon a "light diet" for the treatment of his arthritis; this consisted principally of vegetables, fruit, and carbohydrates, and no meat. When his urinary symptoms commenced he was given alkalis by mouth. He would almost certainly, therefore, have a urine which was on the alkaline side of neutrality. The stones in the right kidney were almost complete casts of many of the calices, and there were large dense masses in the pelvis.

TREATMENT.—The patient was put on the acidogenic diet, with vitamin A and large quantities of fluid. He was turned, still in his spica, several times daily, on to his sides for short periods. Later the plaster was removed and he was allowed to walk about wearing a calliper splint. The stones in the left kidney were shown by a later radiograph to have entirely disappeared; those from the right kidney were considerably reduced in size, at first fairly rapidly, but later their diminution seems to have come to a standstill. During the first part of the treatment he passed visible blood and a considerable quantity of grit in the urine.

Case 3.—A. G., female, age 31.

HISTORY.—In September, 1931, the patient was found to be suffering from Pott's disease of the twelfth dorsal and first lumbar vertebræ; she was treated on a Bradford frame for six months, after which in February, 1932, a Hibbs spinal fusion was performed. In June, 1932, the patient was allowed to walk about with a back-support. There was no history of any blood being passed in the urine during recumbency. Almost immediately after commencing ambulatory treatment the patient complained of a pain in the right loin. A radiograph (Nov. 26, 1934) showed a large calculus in the right kidney. An inspection of a radiograph taken shortly after her operation in February, 1932, showed a smaller shadow in the same locality which had not been present on the first radiograph taken when the diagnosis of Pott's disease was made. The urine (Nov. 26, 1934) contained a large amount of pus and numerous *B. coli*, and was alkaline in reaction. On cystoscopy, pus was being discharged down the right ureter; the left kidney was secreting perfectly normally. A diagnosis of calculous pyonephrosis was made.

TREATMENT.—In February, 1934, right nephrostomy was performed. A large number of small stones and much mud and pus were evacuated. The patient made a good recovery.

Case 4.—H. S., male, age 26.

HISTORY.—The patient was admitted to the Leeds General Infirmary on January 13, 1937, suffering from a fracture-dislocation of the lumbar spine, with involvement of the third, fourth, and fifth lumbar vertebræ. There was slight loss of power in the right leg and considerable loss of power in the left leg. He developed acute retention of urine for which a catheter was tied in the urethra. By January 30, 1937, the patient had developed an acute cystitis and the urine was found to contain blood and pus. By the middle of March the patient had so far recovered that he was allowed to sit up, and on March 16 he developed left renal pain and difficulty on micturition. By this time, power had returned to the legs. In April he had a number of rigors. A radiograph taken on May 3, 1937, revealed many calculi in the left kidney. Further examination of the urine showed it to be loaded with pus, and it yielded a growth of *B. coli* on culture. Cystoscopy (May 10, 1937) showed that the right kidney was functioning normally but that the left kidney was secreting purulent urine.

TREATMENT.—In May, 1937, the left kidney was explored and a calculous pyonephrosis was found. Left nephrectomy was performed. On sectioning the kidney there were many calculi of varying sizes in the pelvis and calices. The pelvis contained a considerable amount of pus. The patient made an uneventful recovery.

Case 5.—N. R., female, age 19.

HISTORY.—The patient was admitted to Leeds General Infirmary on September 16, 1935, with a compound fracture in the lower third of the left femur and a fracture of the right tibia. The wound of the left femur was badly soiled and severe septic complications followed. Four weeks after admission she complained of pain in the right kidney and an examination

of the urine yielded a heavy growth of streptococcus. Following this, she had intermittent right renal pain, and on December 30, 1935, a right pyonephrosis was diagnosed. The patient was extremely ill, not only from the pyonephrosis but also from a severe septic wound of the thigh. A radiograph on April 25, 1936, showed stones in the right kidney.

TREATMENT.—Amputation of the leg was found necessary, and was performed on May 1, 1936. When the wound was almost healed and the patient was allowed to get up and about on crutches she had renal colic, at first on the right side and then on the left, and both attacks of colic were followed by the passage of small calculi of varying size. On January 23, 1937, a right nephrostomy was performed for right-sided calculous pyonephrosis; several calculi and a large quantity of pus were evacuated. The patient improved after this operation, but later she had attacks of colic on both sides, with passage of further calculi, and in June, 1937, she developed calculous anuria. A stone was removed from the left ureter, but she died a few days after the operation. An autopsy showed the presence of bilateral pyonephrosis.

Case 6.—J. A. W., male, age 30.

HISTORY.—During 1930 the patient was recumbent for nine months with a fractured femur. In 1931 he was operated on for calculous pyonephrosis affecting the right kidney, the calculi having developed during recumbency; a second operation was performed for the same condition in January, 1935. In September, 1936, the patient had further attacks of renal colic, and a radiograph on October 4, 1936, revealed multiple calculi in the right kidney, a large calculus in the left ureter, and one in the bladder. On September 8, 1936, a stone was removed from the bladder and a second stone was removed from the lower end of the left ureter. The patient died on October 25, 1936. An autopsy revealed large irregular phosphatic staghorn calculi in the right kidney, which was the seat of a pyonephrosis. There was also a right-sided perinephric abscess. There were no stones in the left kidney, but this showed evidence of infection.

Case 7.—A. I., male, age 30.

HISTORY.—The patient was treated in the recumbent position for three years for tuberculosis of the lower dorsal spine (1924–1927). While still recumbent he passed blood in the urine and later had pain in the region of the right kidney. In the early radiograph no calculi were visible. A radiograph in 1927 revealed two calculi in the pelvis of the right kidney. The blood urea-nitrogen was 20·2 mg. per 100 c.c.

TREATMENT.—The calculi were removed by pyelolithotomy (1927). The patient made a normal recovery.

FURTHER CASES

We have, in addition, seen four examples of hæmaturia occurring in patients, mostly children, who have undergone treatment in recumbency for tuberculous conditions of the hip and spine, but in whom the radiographs have not revealed any gross calculi. The investigations did not reveal any infective or tuberculous lesions of the urinary tract, and we believe that most of these patients had developed tiny calculi, though we are unable to prove this. The institution of the treatment outlined in this paper resulted in a cessation of urinary symptoms and appeared to prevent any further attacks of hæmaturia.

SUMMARY

1. The morbid anatomy and symptomology of calculi occurring in recumbent patients are described.

2. The aetiological factors are discussed. It is considered that the most important factors are general and local decalcification of bone, dehydration of the patient, stasis in the renal calices and pelvis as a result of the recumbent posture, and dietetic and other factors resulting in the production of a non-acid urine. There is not sufficient evidence that hypervitaminosis D is an aetiological factor.

3. The measures are outlined which are desirable for the prevention of recumbency calculi; it is shown that in cases of actual calculus formation it is possible to cause the calculi to go into solution if appropriate treatment is carried out, providing the calculi remain aseptic.

We desire to express our thanks to Mr. L. R. Braithwaite, Mr. E. R. Flint, and Mr. R. Broomhead for allowing us to record cases which have been under their care. We also desire to thank the Consulting Staff of the Robert Jones and Agnes Hunt Orthopædic Hospital, Oswestry, for allowing us to investigate patients under their care, and Mr. R. G. Pulvertaft for his very kind collaboration in the investigations.

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PERIODICITY IN CANCER AND OTHER NEOPLASTIC DISEASES (450 CASES)

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CANCER cured by operation or radiotherapy soon after the first onset of signs shows no indication of being a periodical disease. But analysis of its recurrent phases as suggested recently (Webster,[15] 1938) has shown cancer to be one of a group of neoplastic diseases having a thirty-three weeks' periodicity. This new conception opens out possibilities of considerable advance in the practical control of cancer and in comprehension of its essential nature.

The earliest possible detection of recurrence may be of vital importance for the patient, as the earlier a recurrence is submitted to appropriate treatment the better is the prognosis. Thus in 1925 the author showed that in one series of breast cases the earliest local recurrences following operation disappeared after X-ray treatment in 88 per cent of patients: but the three-year 'cure' of 'major recurrences' in 165 cases was only 22 per cent (Webster,[11, 12] 1925, 1928). The contrast was a significant one: early treatment gives a much higher probability of cure in each case (other factors being equal). But until now there has been no known method for early detection save the impracticable one of examining all cancer patients at monthly intervals, a method which even if feasible might be injurious to some patients from the psychological point of view. The knowledge of periodicity, however, has already enabled correct predictions to be made of probable recurrence weeks, and has transformed the appearance in patients' case-histories of wholly random happenings of fresh signs of disease into a regular pattern or system (followed out in some patients even for fifteen years or longer) of a thirty-three weeks' cycle (eight lunar months), or with half-periods (four lunar months), with the active peaks occurring either singly or in multiples as missed periods.

Of all recurrent patients, 96 per cent have shown this periodicity clearly, apart from patients with very chronic tumours or with tumours in inaccessible sites, or from those who had not been followed up closely. The eight lunar months' span has been chosen as the standard, because in carcinoma and leukæmia cases over twice as many single full periods have been seen or calculated as half periods (in one series as 344 to 137), and this predominance of full periods has been as evident when multiples have been added (as 471 to 212). In sarcoma and Hodgkin's disease the half periods have nearly equalled the full periods. The possible significance of half periods will be discussed below. The surmise may be hazarded that had only full periods been shown, the periodicity of recurrences would have been discovered long ago.

Periodicity has now been traced in detail in 450 neoplastic patients: the following is a brief summary of the observations made:—

1. CARCINOMA

a. **Breast Cancer** (120 cases, all but 3 clearly showing periodicity).—

Example.—Case showing 6½ periods (F. T., age 58).

½	1934	*February*: Three years' history; huge inoperable primary (10 × 14 cm.); had been growing rapidly lately. R. and L. axillary and L. supraclavicular glands: X-ray treatment, March; greatly improved. April 26, radical mastectomy by Mr. Gordon-Taylor.
½		*June* 6: Three scar nodules.
1		*October* 22: Fresh skin nodules.
1	1935	*April* 29: New nodules.
1	1936	*January* 14: Fresh recurrences.
1		*September* 1: New axillary scar nodules; opposite breast recurrence.
1	1937	*April* 28: New scar nodules.
½		*December* 20: Three fresh skin recurrences (sternal).
	1938	*April* 25: Fresh group (scapular).

Note: All recurrences were treated with deep X rays; in December, 1936, suspicious 5th dorsal spine and pelvic signs; patient with good natural resistance.

b. **Oral Cancer** (62 cases, all showing periods).—

Example.—Case showing 17 periods, 11 active peaks (? 23½ periods) (R. B., age 63; floor of mouth, alveolar).

½	1923	*February*: Dental mould burn.
1½		*June*: 'Ranula' excised.
4½	1924	*April–May*: L. alveolar leukoplakia; diathermy.
1	1927	*February*: Patient noticed warty growth, floor of mouth and to L.
		July 4: Diathermy and radium by Mr. Handley; L. side.
1		*October* 5: Recurrent papillomatous nodule, L. alveolus.
2	1928	*May* 2: ? R. tongue invasion (middle R.)
6	1929	*August* 7: ? R. alveolar recurrence: was definite recurrence, September 11.
1	1933	*July* 17: Alveolar nodule.
1	1934	*March* 21: R. alveolar recurrence.
1		*October*: L. tongue and gland.
1	1935	*June* 27: Suspicious L. tongue and anterior pillar nodule (definite when seen in September).
2	1936	*February–March* 12: Nodule in tonsil fossa.
1	1937	*June* 3: Small alveolar recurrence, L.
	1938	*January* 20: Very tender area between mid-tongue and alveolus; no definite recurrence; later, recurrence definite.

Note: Apparently a 33½ week case, gaining 8 weeks in 17 periods (11 years): ? a double primary case. Treatments with diathermy and radium, by applicators, insertion, or teleradium. To 1927 the history was only the patient's: he was abroad then (no proof of malignancy in 1924).

c. **Vesical Carcinoma** (12 cases, all with periods).—

Example.—Case showing 6½ periods (W. A., male, aged 68; transitional-celled carcinoma).

3	1932	*December*: Hæmaturia for a week.
1	1934	*November*: Recurrence; partial cystectomy by Mr. (now Sir) Alfred Webb-Johnson.
1	1935	*May*: Recurrence; diathermy.
1½	1936	*January*: Sessile recurrence; diathermy.
	1937	*January*: Died.

Note: Shows the frequently seen record of death at a period or half period.

d. **Thyroid Carcinoma** (6 cases, all with periods).—

Example.—Case showing 11½ periods (G. F., male, aged 71).

3	1930	*Autumn*: Onset of signs.
	1932	*August*: Increased growth.
1		*October*: Operation by Mr. E. L. Pearce Gould.
5	1933	*March*: Recurrence; X rays.
2½	1936	*May*: Fresh recurrence; radium gramme unit.
	1938	*January*: Recurrence again.

Note: Irradiation for recurrence following the operation led to a remission for over three years; again, for one and a half years.

In addition to the above-mentioned 199 cases of carcinoma there have been analysed 83 other carcinoma cases, making 282 in all, almost all showing well-marked and constant periodicity of the usual full- or half-period type. The series included, amongst others, carcinoma of the skin, larynx, œsophagus, kidney, penis, rectum, cæcum, cervix, ovary, and parotid.

2. INTERMEDIATE GROUP

(31 cases, all showing periods)

Patients with testicular malignancy and those with melanotic tumours are here grouped, as (apart from the teratomas and seminomas) some were classified as 'carcinoma' and others as 'sarcoma'. There were 20 testicular and 8 melanotic cases; 3 glioma cases are included also (2 cerebral, 1 orbital).

Testicular Malignancy (20 cases, all with periods).—

Example.—Case showing 3½ periods (T. B., age 26; teratoma).

½	1935	*February*: Blow and swelling.
		May: Increase.
½		*July*: Orchidectomy and X-ray treatment to (?) aortic gland; early metastasis probable (half period from March).
2	1936	*October*: Scar recurrence; X rays. Patient was well until March, 1937.
½	1937	*March*: Reported with chest secondaries, and soon had spinal metastases.
		June: Died.

Note: Following the post-operative X-ray treatment, apparent cure for one-and-a-half years; incomplete follow-up; delayed observation of chest signs.

3. SARCOMA

(34 cases, all but 2 showing typical periods)

Example.—Case showing 9½ periods (G. F., female, aged 53, lymphosarcoma).

5	1931	*Summer*: Glands in neck.
	1934	*July*: X-ray treatment began.
1	1935	*March*: Axillary tail and groins enlarged.
½		*July*: Fresh enlargement of neck and axillary glands.
+½		*August*: Nothing palpable.
	1936	*January*: Reported again with new neck and axillary gland enlargement and much enlarged spleen (delayed observation of a half period).
−½		*March*: Spleen; more X-ray treatment.
1		*May*: Very well.
		October: Spleen much increased.
1	1937	*May*: Died.

Note: Controlled for nearly three years by X-ray therapy.

Example.—Case showing 7½ periods (P. B., female, aged 28, Ewing's sarcoma).

½	1931	*December*: Rapidly growing painful swelling of elbow; operation—incision, fluid contents.
½	1932	*April*: Signs again; May, operation.
1½		*July*: Acute recurrence; operation—bone scraped.
½	1933	*July*: Recurrence; operation and biopsy by Mr. E. L. Pearce Gould.
4½	1933	*November*: Began growing again; radium applications in January, 1934.
	1936	*September*: Had been increasing for "six months"; X-ray treatment.
	1937	*April*: Ulcer healing; no recurrence.
		December: Sequestrum separating; no recurrence.

Note: Sections were confirmed by Dr. Ewing. Another Ewing's sarcoma case showed three full periods of activity, ending with death at a period.

The 34 patients with sarcoma included 12 with lymphosarcoma, 13 with soft tissue tumours, 4 osteogenic sarcomas, 2 osteoclastomas, and 2 Ewing's sarcomas.

4. LEUKÆMIA

(31 Cases: 18 myeloid; 12 lymphatic; 1 monocytic—all showing periods, some rather irregular)

Example.—Myeloid case showing four periods (L. B., female, aged 26).

	1934	*October*: White blood-corpuscles 183,000; X-ray treatment; improved.
2	1935	*October*: White blood-corpuscles 24,000.
		November: Patient well.
	1936	*February*: Relapse; white blood-corpuscles 146,000.
1		*April*: White blood-corpuscles 37,600; improved.
		November: Relapse; white blood-corpuscles 165,000.
1		*December*: Improved; white blood-corpuscles 64,000.
	1937	*July*: Died.

Note: Marked improvement over two periods at first, following X-ray treatment; less improvement later on after X-ray; death at a period.

Example.—Lymphatic case showing 7½ periods (S. C., female, aged 64).

3	1930	*Summer*: Neck gland enlarged.
	1932	*June*: 53,000 leucocytes; X-ray treatment—neck glands, axillæ, groins.
1		*August–September*: Much improved; 5200 white blood-corpuscles.
	1933	*January*: Increased glands again: 11,000 white blood-corpuscles.
1		*April*: Better.
		July: Again enlarged glands.
1		*December*: Very well; no glands palpable.
	1934	*February–March*: Relapse; white blood-corpuscles 22,000.
1		*July*: Better again.
		September: Glands larger again and abdominal swelling; white blood-corpuscles 51,000.
½	1935	*January*: Died.

Note: Apparently a thirty-week case; death at a half period.

The evidence in favour of the neoplastic nature of leukæmia has been summarized well by R. A. Willis[16] (1934). In fowls leukæmia has been shown to be due to a filter-passing virus which may induce leukæmia or sarcoma on inoculation (C. Oberling and M. Guérin[7] (1934) and J. Troisier[10] (1935)).

5. LYMPHADENOMA

(44 cases (1 developing a liver sarcoma), all but 3 showing periods)

Example.—Case showing 4½ periods (G. H., male, aged 26).

½	1934	*December*: Glands—neck, axillæ.
1½	1935	*April*: Mediastinal glands. X-ray treatment; better.
1	1936	*February*: Tender axillary gland.
½		*September*: Opposite axilla.
½	1937	*January*: Epigastric mass.
½		*May*: Hæmoptysis.
½		*August*: Died.

Lymphadenoma has resemblances both to neoplasia and to infective diseases; evidence in favour of its virus origin has accumulated—*see* M. H. Gordon (1932); G. P. Chandler[3] (1934).

6. LYMPHOBLASTOMA (rare types):

a. **Mycosis Fungoides** (5 cases: one showing Hodgkin's disease post mortem).

b. **Mikulicz's Disease** (1 case).

All showing periods.

Example.—Case showing 11 periods—4 active ones in 7 years: (E. W., female, aged 28; Mikulicz's disease).

2	1928	*June*: Lacrymal gland swollen.
1	1929	*September*: Several new glands.
8	1930	*May*: Parotid and submental glands enlarged; X-ray treatment; clinical cure.
	1935	*April*: Left neck two small glands, and small nodule (1½ cm.) lower left costal margin; X-ray treatment; cure maintained.

Note.—Included owing to its rarity; blood-counts were normal; no biopsy; showed extreme radiosensitiveness.

7. BENIGN NEOPLASMS (PAPILLOMATA, etc.)

(12 cases, all but 2 showing periods)

Example.—Case with vesical papillomata showing $7\frac{1}{2}$ periods (M. M., female, aged 65).

$1\frac{1}{2}$	1933	*August*: Hæmaturia for a week.
		October: Diathermy to three papillomata.
5	1934	*August*: One small recurrence.
	1937	*January*: Two small recurrences.
1		*October*: One small papilloma.

Note: Treatments by diathermy. There were five other patients with vesical papillomata, and several in the carcinoma group had similar recurrences. Twelve patients had tar or pitch warts, which often appeared periodically in crops and vanished spontaneously. Two cases with laryngeal papillomata showed doubtful periods. Three of the sarcoma group at first had 'recurrent fibroma' with periods. One patient had lymphangioma of the palate and one had angioma of the cheek; both showed periods of activity. More observations are required on benign tumours.

CONCLUSIONS

1. A new conception is presented of cancer as one of a series of neoplastic diseases showing periodicity.

2. The series includes carcinoma, sarcoma, recurrent papillomata, leukæmia, and lymphadenoma (with possibly Mikulicz's disease and other benign neoplasms).

3. The periodicity has been clearly present in 96 per cent of the cases analysed: usually it has been seen in an eight lunar months' period of thirty-three weeks; often in four lunar months' half periods of sixteen-and-a-half weeks. The variability has been one of plus or minus three weeks: such variations have been rare, but when seen have sometimes been followed out for many consecutive periods.

4. The periodicity has been recognized most easily in superficial recurrences, or in those readily accessible to clinical examination, or to demonstration by X rays. In very chronic or inaccessible tumours little or no sign of periods can be traced.

5. Neither surgical treatment nor irradiation has appeared to have an influence on periodicity. This has been shown by patients for whom a peak of rapid growth had been determined before the treatment began: recurrences followed at periods or half periods irrespective of the treatment. The alternatives appear to be cure or periodicity.

6. Fallacies in the determination of periods have been due mainly to delayed observation of the clinical onset or early periods of primaries, or of the earliest recurrent signs. The time-lag between microscopical origin and clinical appearance must vary greatly in different tumours, and growth-rates vary greatly, but the growth-rates of recurrences of the same tumour in the same patient rarely have varied much, except for the acceleration seen often in terminal stages.

7. For a high degree of statistical accuracy a series of patients with recurrent tendency should be examined at weekly intervals before and during probable recurrent maxima. The most conclusive proof of periodicity would appear to be success in prediction of recurrences, and already several successful predictions have been made.

8. Full periods have been seen more than twice as often as half periods in cases of carcinoma and leukæmia. The full period, therefore, has been chosen as

the standard interval. No sign of any other period has been traced in patients closely followed up, and where a distinction has been drawn between variations in the size of an established growth and a true recurrence (after absent or almost entirely absent signs). In established growth in patients in the terminal stages of disease no longer responding to irradiation, in a few cases suggestions of minor periods of eight or twelve weeks have been seen: if confirmed this would be a phenomenon in patients similar to the observations of Bashford[1, 2] and others of approximately eight weeks' maximal growth-periods in some animal tumours.

9. In several patients with multiple primaries the signs of onset of the primaries (and any recurrences) have all fallen within one periodical scheme, as though each patient had had one disease with differing site manifestations (18 patients).

10. Neoplastic periodicity seems to bring forward circumstantial evidence in favour of the virus theory of cancer, as discussed, for example, by W. E. Gye[6] (1936, 1938), and referred to by Webster[14] (1937). A virus origin is very probable for human leukæmia and lymphadenoma (proved for some skin papillomata, fowl-leukæmia and fowl-sarcoma), and no other cause for the periodicity but a virus presents itself: it alone seems capable of explaining the finding above in (9).

11. In several patients recurrences have regularly appeared about three weeks after an influenzal attack (at thirty-three week periods or multiples), but in most patients no association whatever with influenza has been apparent. The dates of recurrences as compared with those of influenzal maxima will be discussed elsewhere.

12. Analysis of the dates of recurrences has shown that in breast cancer, sarcoma, leukæmia, and Hodgkin's disease almost half as many again have been in the first four months of the year as in each of the two other four-month groups. This finding confirms the observations of Peacock[8] and of Fraenkel[4] on seasonal periodicity in animal tumours. Growth and transmissibility are more vigorous in the 'egg-laying months'. (In one series analysed—breast, sarcoma, and Hodgkin's disease—the figures were as 130 in January to April, to 90 in May to August, or to September to December, inclusive.) The interpretation, however, as to the causal factor is difficult—possibly one inherent to the growth—but the patients' or hosts' resistance was probably at its minimum in January to April; again, sex-hormone production was probably then on the increase.

13. The half periods may indicate a double infection, as in a double tertian malaria infection. (Half periods have been seen most commonly in sarcoma and Hodgkin's disease.) The signs in several patients have suggested a double infection, e.g., a breast case in which supraclavicular glands recurred at a full period, while midway between the peaks of the supraclavicular gland period came the first peak of mid-neck gland recurrences, also having their full period. The *patient* showed half periods. Consideration of other patients showing isolated half periods (periods then being resumed) suggests rather that, on a virus theory, either a chemical change or stimulus occurs, or a vital reproduction occurs, at the half period instead of at the full term or its multiple, owing either to inherent seasonal or other accentuation of growth, or to the patient's loss of resistance. Animal experiments have not yet determined the relative importance of the tumour cells (Bashford[1]) or the host's resistance (Selbie[9]) in growth variations.

14. Important practical applications of neoplastic periodicity are suggested in the fields of prevention, diagnosis, prognosis, and treatment.

a. Prevention of recurrences may result from prophylactic irradiation or other

treatment given before the expected peak of growth activity. This has been tried already with X rays in several patients. The earlier a recurrence is treated the better the result is likely to be (as mentioned above), and smaller doses of X rays than those required for established primaries or secondaries should lead to disappearance (Webster,[12, 13] 1928, 1932). The radiosensitivity is greater (other things being equal) the smaller the growth; and this would appear to be still more applicable if only microscopic foci in an early dividing stage, and about to become clinically evident, are irradiated: this theory could possibly be tested best in leukæmia patients.

Prevention of primary neoplastic disease should be enhanced (if these observations are confirmed and it is agreed that they support the virus theory) by further researches on virus pathology and the predisposing factors to infection, and on susceptibility and immunity to tumours.

b. The diagnosis of recurrences which are doubtful is rendered more probable if the new signs in the patient (or in any growth-residue—? inflammatory, fibrotic, or neoplastic) occur at a maximal period or half period.

c. In prognosis the weeks and months of possible recurrence may be told in advance with reasonable accuracy once the patient's periodicity has been determined (in primary cases by any sudden increase in the tumour size, and in recurrent cases by the earliest signs of new local or distant metastases). Also the probable month of death of patients in the terminal stages of metastasis may be foretold with some approach to accuracy in cases not complicated by other diseases, e.g., renal or cardiac. This conclusion follows from the great number of deaths which occurred at or close to maximal peaks (this finding also would seem to support the virus theory).

d. For treatment to be at the earliest possible time, the patients should be observed specially when nearing, during, and for some time after the periodic maxima (full and half periods): and the follow-up should continue for many years. The many instances seen of missed or latent periods suggest the presence of a quiescent virus, which germinates when its own inherent cycle of activity happens to coincide with the host's lowered resistance or hormonal stimulus. Re-infection cannot be excluded, but would be unlikely at a period. On the virus theory very prolonged observation of patients seems indicated: and by it alone appear explicable the very long latent periods sometimes seen before recurrence.

e. In treatment of early recurrence X rays and radium given in adequate dosage and time, and to a wide enough area of the recurrence and its neighbouring field, especially to its lymphatic drainage areas, offer the best known hope of cure for most cases with secondary neoplastic disease. The 'in advance' method should be used for recurrences, as for the primary disease (Webster,[11] 1925). Thus the dorsal spine should be given X-ray prophylactic treatments if lateral chest wall or scapular skin recurrences appear. X rays by teleroentgentherapy methods may also prove valuable in the treatment of the earliest recurrences, if disseminated, or to raise the resistance of patients (by small doses) before expected maximal peaks.

SUMMARY

1. Periodicity in recurrences has been traced in 282 cases of carcinoma and 34 cases of sarcoma.

2. A similar periodicity has been found in patients with leukæmia, lymphadenoma, and some benign neoplasms (e.g., skin and vesical papillomata).

3. Of the two periods found, the more usual has been an eight lunar months' one (thirty-three weeks), with a plus or minus three weeks' variability. As much the more common term, this has been chosen as the standard.

4. Many half periods have been seen, and have been found relatively more common in sarcoma and Hodgkin's disease.

5. Many missed or latent periods have been traced: recurrence has followed as if the periods had been active.

6. Several patients with multiple primaries (successive) have shown these and the recurrences all falling into one periodical scheme.

7. Many patients have died at or close to a periodical maximum.

8. A seasonal periodicity has been found with a maximum in January to April (confirming some results with animal tumours).

9. Minor fluctuations (of eight or twelve weeks) have been suggested in a few cases with established disease in terminal stages (an eight weeks' period has been seen in some (transmitted) animal tumours).

10. It is suggested that the observations (1) to (7) are consistent with the theory that a virus plays the part of cell stimulant in cancer.

APPENDIX

Quick calculations of periodicity dates in series are impossible without the use of tables: the two given below have proved invaluable. From *Table I* can be

Table I.—Periodicity Based on 33-week Intervals.

Date	Half Periods (16½ Weeks)	Periods (33 Weeks)
Jan. 1 ..	April 26 ..	Aug. 20
„ 15 ..	May 10 ..	Sept. 3
Feb. 1 ..	May 27 ..	Sept. 20
„ 15 ..	June 10 ..	Oct. 4
March 1 ..	June 24 ..	Oct. 18
„ 15 ..	July 8 ..	Nov. 1
April 1 ..	July 25 ..	Nov. 18
„ 15 ..	Aug. 8 ..	Dec. 2
May 1 ..	Aug. 24 ..	Dec. 18
„ 15 ..	Sept. 7 ..	Jan. 1
June 1 ..	Sept. 24 ..	Jan. 18
„ 15 ..	Oct. 8 ..	Feb. 1
July 1 ..	Oct. 24 ..	Feb. 17
„ 15 ..	Nov. 7 ..	March 3
Aug. 1 ..	Nov. 24 ..	March 20
„ 15 ..	Dec. 8 ..	April 3
Sept. 1 ..	Dec. 25 ..	April 20
„ 15 ..	Jan. 8 ..	May 4
Oct. 1 ..	Jan. 24 ..	May 20
„ 15 ..	Feb. 7 ..	June 3
Nov. 1 ..	Feb. 24 ..	June 20
„ 15 ..	March 10 ..	July 4
Dec. 1 ..	March 26 ..	July 20
„ 15 ..	April 9 ..	Aug. 3

Table II.—Showing 33-week Intervals from 1925–1945.

(1925) **1932** (1939)	(1925) **1932** (1939)	(1926) **1933** (1940)	(1927) **1934** (1941)	(1927) **1934** (1941)	(1928) **1935** (1942)	(1929) **1936** (1943)	(1929) **1936** (1943)	(1930) **1937** (1944)	(1930) **1937** (1944)	(1931) **1938** (1945)
April 6	Nov. 23	July 27	March 15	Nov. 1	June 20	Feb. 6	Sept. 24	May 13	Dec. 30	Aug. 18
13	30	Aug. 3	22	8	27	13	Oct. 1	20	**1938** 6	25
20	Dec. 8	10	29	15	July 4	20	8	27	Jan. 13	Sept. 1
27	15	17	April 5	22	11	27	15	June 3	20	8
May 4	22	24	12	29	18	March 5	22	10	27	15
11	**1933** 29	31	19	Dec. 6	25	12	29	17	Feb. 3	22
18	Jan. 5	Sept. 7	26	13	Aug. 1	19	Nov. 5	24	10	29
25	12	14	May 3	20	8	26	12	July 1	17	Oct. 6
June 1	19	21	10	**1935** 27	15	April 2	19	8	24	13
8	26	28	17	Jan. 3	22	9	26	15	March 3	20
15	Feb. 2	Oct. 5	24	10	29	16	Dec. 3	22	10	27
22	9	12	31	17	Sept. 5	23	10	29	17	Nov. 3
29	16	19	June 7	24	12	30	17	Aug. 5	24	10
July 6	23	26	14	31	19	May 7	24	12	31	17
13	March 2	Nov. 2	21	Feb. 7	26	14	**1937** 31	19	April 7	24
20	9	9	28	14	Oct. 3	21	Jan. 7	26	14	Dec. 1
27	16	16	July 5	21	10	28	14	Sept. 2	21	8
Aug. 3	23	23	12	28	17	June 4	21	9	28	15
10	30	30	19	March 7	24	11	28	16	May 5	22
17	April 6	Dec. 7	26	14	31	18	Feb. 4	23	12	**1939** 29
24	13	14	Aug. 2	21	Nov. 7	25	11	30	19	Jan. 5
31	20	21	9	28	14	July 2	18	Oct. 7	26	12
Sept. 7	27	**1934** 28	16	April 4	21	9	25	14	June 2	19
14	May 4	Jan. 4	23	11	28	16	March 4	21	9	26
21	11	11	30	18	Dec. 5	23	11	28	16	Feb. 2
28	18	18	Sept. 6	25	12	30	18	Nov. 4	23	9
Oct. 5	25	25	13	May 2	19	Aug. 6	25	11	30	16
12	June 1	Feb. 1	20	9	**1936** 26	13	April 1	18	July 7	23
19	8	8	27	16	Jan. 2	20	8	25	14	March 2
26	15	15	Oct. 4	23	9	27	15	Dec. 2	21	9
Nov. 2	22	22	11	30	16	Sept. 3	22	9	28	16
9	29	March 1	18	June 6	23	10	29	16	Aug. 4	23
16	July 6	8	25	13	30	17	May 6	23	10	30
23	13	15	Nov. 1	20	Feb. 6	24	13	30	18	April 6
30	20									
Dec. 7	27									
(1925) **1932** (1939)	(1926) **1933** (1940)	(1927) **1934** (1941)	(1927) **1934** (1941)	(1928) **1935** (1942)	(1929) **1936** (1943)	(1929) **1936** (1943)	(1930) **1937** (1944)	(1930) **1937** (1944)	(1931) **1938** (1945)	(1932) **1939** (1946)

read easily the next half and full period from any date on which a patient presents signs of rapid growth in a primary or the earliest signs of recurrence. *Table II* is useful when analysing case histories: it gives accurately the years 1932 (April) to 1939 (April)—also, with slight dovetailing, the years back to 1925 and forward to 1945—correctly to a day or two (the leap years being 1928, 1932, 1936, 1940, and 1944).

In *Table II* a patient showing full periods or multiples in the history will have had recurrences at dates horizontally across the page; slight variation in the period, more or less, will give a line with slight obliquity across. Half periods may be read as half columns.

Confirmation of periodicity in cancer has come from Professor Berven (Stockholm), who agrees (personal communication) that periodicity is shown in many of the case-histories of patients with recurrences among the 100 cases detailed in his book *Malignant Tumours of the Tonsil* (1931, Stockholm). Berven also has found periodicity "probable" in some cases seen lately at Radiumhemmet.

In conclusion, acknowledgements should be made to Professor R. A. Fisher for valuable suggestions as to the statistical problems involved; to Professor J. M. Woodburn Morison and Dr. Norman Sampey for details of pitch wart cases; and to many colleagues in the Middlesex Hospital for clinical memoranda, particularly to Sir Alfred Webb-Johnson and Mr. E. W. Riches for notes on vesical patients, and to Dr. C. E. Lakin and Professor James McIntosh for notes of leukæmia patients specially studied in the S. A. Courtauld Clinical Research Wards.

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THE ANTERIOR BASAL MENINGIOMAS*

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INTRODUCTION

WHILE the results of surgical treatment of the intracranial meningiomas are on the whole very gratifying, which should be so with tumours that are extracerebral and encapsulated, there remains a small proportion of cases in which the outcome is disappointing. The chief causes of failure are, firstly, the precise type of the meningioma, and secondly, its position.

The meningiomas do not have a constant histological structure, but show variations which recur sufficiently often to allow of classification into sub-groups. Thus, at one end of the scale is the slowly growing, firm, psammomatous type, less vascular than most meningiomas, and often associated with a long clinical history; these tumours are easy problems surgically, unless they lie in relatively inaccessible situations. At the other end of the scale is the angiomatous type, which may present insuperable difficulties at operation owing to its extreme vascularity.

In considering the influence of site upon mortality, it is easy to understand that those meningiomas which lie on the cranial base are more difficult technical problems than those lying under the vault. The basal tumours are usually completely hidden by the brain, of which it may be necessary to excise relatively large portions, where this is practicable (having regard to its physiological value), in order to obtain access. The ease, or even the possibility, of this step depends largely on the degree of intracranial pressure. The size of the tumour is naturally an important factor in this connection, and those on the floor of the anterior fossa are apt to attain great size because they give rise to few symptoms, or to symptoms which can easily be interpreted as indicating some other and less important malady. Another surgical peculiarity of these tumours is that they overlie their point of origin and chief source of blood-supply, so that, whereas in the convexity group the dural attachment is isolated first, in the basal group the concealed origin of the tumour can only be attacked last. Again, the close contact of their deep surface with the optic nerves and important vessels always causes anxiety, for these structures are not visible until the tumour has actually been delivered, and the fear of injury to them may cause the surgeon to leave behind a small piece of the tumour. It may be of value, therefore, to present a series of cases which illustrate the difficulties of removing these relatively inaccessible tumours.

A description is given of six patients with anterior basal meningiomas personally observed in the National Hospital during the past year (1935–36). These include patients with tumours arising from the olfactory groove, and from the inner or outer portions of the sphenoid ridge. They illustrate points of clinical interest, the technical difficulties encountered during operation, and the use of certain operative procedures which facilitate their successful removal. In order to amplify the clinical syndrome of each group, I have had the opportunity of analysing the

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case records of patients with similar tumours which have been verified histologically, either by surgical removal or at autopsy, during the last eight years. Only a brief summary of the symptomatology will be given, as the syndromes have already been fully described by various observers. The total number of cases from the National Hospital thus summarized, including the illustrative examples, is 45—namely, 12 with tumours of the olfactory groove, 13 of the tuberculum sellæ, and 5 of the inner part and 13 of the outer part of the sphenoid ridge, and a brief reference is made to 2 cases with pre-olfactory tumours.

THE MENINGIOMAS IN GENERAL

Cushing,[1] in 1922, in a general survey of the extracerebral meningeal tumours—frequently called dural endotheliomas—suggested the name 'meningioma' as a convenient clinical term to avoid the confusion of the cumbersome terminology which had arisen on a histopathological basis. It was then becoming generally recognized that these tumours, though firmly attached to the dura mater, do not arise from that membrane, but rather from elements of the arachnoid which project into it. Small clusters of cells which are of arachnoidal origin are normally found between the layers of the dura; they develop into the arachnoidal villi, of which the more hypertrophied are visible as the Pacchionian granulations. These arachnoidal projections are most numerous and attain their maximum development in the region of the dural venous sinuses, both over the convexity, especially in the parasagittal region, and on the skull base. It is in these situations that meningeal tumours most frequently occur. The general belief that meningiomas are derived from arachnoidal projections is based largely upon the similarity of their distribution and the resemblance of their microscopical structure.

Various observers have held the belief on general pathological grounds that these tumours are specific growths of the meninges, and are not comparable with endotheliomas which occur elsewhere. Del Rio-Hortega[2] emphasizes the point that the layer of arachnoidal cells from which these tumours are derived does not have the structure of an endothelium, and in fact resembles no other tissue in the body. In order to stress the fact that it forms the outer layer of the leptomeninges and is not dural endothelium, he has called it exothelium, and the tumours derived from it 'exotheliomas', of which he recognizes several varieties.

These growths, then, variously called meningioma, meningeal or arachnoidal fibroblastoma, dural endothelioma, psammoma, and even sarcoma, derive ultimately from the arachnoid, but are firmly attached to the dura from the beginning. Their chief blood-supply enters through the dural attachment, but sometimes an important collateral circulation is obtained from the pia mater in the tumour bed. The tumours usually grow inwards, slowly displacing the brain but not invading it. They may also extend outwards through the dura and infiltrate the bone, which becomes either eroded or thickened, and may cause a prominence upon the skull. Morphologically, meningiomas are of two chief types. The common variety is a massive, rounded, and often nodular growth which becomes deeply embedded in the brain, and may reach a very large size while its dural attachment remains small. The relatively rare flat meningioma-en-plaque, on the other hand, is only slightly elevated, but tends to spread widely over a large area of the dura; it usually produces a marked diffuse thickening of the overlying bone, which is often mistaken for an osteitis or diffuse osteoma.

Although the meningiomas are characteristically slowly growing tumours, there is great variation in the duration and type of symptoms they produce, and it is perhaps not sufficiently recognized that in many cases the clinical history is of short duration. There are, broadly speaking, two types of clinical history, depending on whether the tumour is related to an important structure (e.g., motor or sensory cortex, cranial nerves), involvement of which produces unmistakable symptoms ; or whether it is over a relatively silent area of the brain. In the former group, the initial focal symptom (e.g., Jacksonian attacks, monocular blindness) usually appears when the tumour is quite small ; it often causes little inconvenience to the patient and may remain the only manifestation for years before the appearance of additional and more serious symptoms, which are generally those of increasing intracranial pressure. Tumours in the second group, on the other hand, remain unsuspected until they are large enough to produce marked increase in the intracranial pressure, the chief effect of which is to cause serious and rapid loss of vision which operation may fail to repair. These differences are well illustrated, in the case of the more familiar tumours under the vault, by the long history of Jacksonian epilepsy which occurs as an isolated focal symptom when the growth is related to the Rolandic area, whereas patients with much larger tumours in the more silent areas of the hemisphere give a short history of general pressure symptoms without any focal manifestations. While the foregoing illustrations serve to underline the chief differences between length of clinical history and actual duration of tumour development, experience shows that this distinction can be brought out even more clearly by a consideration of the basal meningiomas. Because of the close relationship of some of them to the cranial nerves, only a slight difference in the position of the tumour, especially in relation to the optic nerves, is sufficient to produce an entirely different clinical picture. The long history of isolated monocular failure of vision, for example, associated with the tumours arising from the inner part of the sphenoid ridge or the posterior part of the olfactory groove, is a striking contrast to the short history of headache and general failure of vision secondary to papillœdema met with in the more peripherally situated anterior olfactory or outer sphenoid ridge tumours. The length of clinical history, therefore, is determined chiefly by the position of the tumour, and depends to a much less extent on the rate of growth.

The clinical diagnosis of meningiomas depends more upon extracerebral signs (e.g., involvement of a cranial nerve, X-ray changes in the bone) than those of intracerebral damage. Local compression of the brain by a meningioma or other benign encapsulated tumour produces less conspicuous and less disabling symptoms than does the destruction of brain tissue by an infiltrating glioma. The symptoms of a lesion within the cerebral hemispheres (e.g., aphasia, marked hemiplegia, olfactory hallucinations, hemianopia, mental deterioration, and incontinence) by which gliomas are usually localized, are uncommon and late manifestations of meningiomas, and are comparatively unimportant in their diagnosis. The relative effect of each of these two types of tumour, invasive and non-invasive, in causing loss of eyesight, on the other hand, is the reverse, for whereas patients with gliomas become bedridden with paralysis, dementia, and incontinence, etc., before vision is seriously affected by high intracranial pressure, it is quite common for a large meningioma to cause blindness from secondary optic atrophy in an otherwise healthy patient (e.g., *Case* 6). What should be a highly successful result after

removal of the meningioma in such a case is marred by permanent blindness. Removable tumours, and meningiomas in particular, must be diagnosed before the appearance of what have now come to be regarded as advanced signs of a brain tumour.

The important extracerebral signs are, firstly, those of cranial nerve involvement, which reveal many of the basal meningiomas long before the appearance of other symptoms, and, secondly, changes in the bone overlying the dural attachment. X-ray evidence of the latter, chiefly hyperostosis, erosion, or increased vascularity of the bone, can be detected with certainty in many cases; in others, however, these characteristic X-ray signs are entirely lacking. Calcification within the substance of a meningioma is comparatively rare (it is more common in gliomas). A palpable prominence or localized tenderness is occasionally useful in detecting meningiomas under the vault. In many cases there are no extracerebral signs, and the tumour cannot be localized without ventriculography.

For many years, the majority of meningiomas which were removed successfully were situated over the convexity of the brain, where they are more readily accessible, and are likely to be recognized from the occurrence of Jacksonian epilepsy, or through the presence of a palpable bony swelling or conspicuous X-ray changes. Those on the skull base were less often removed, either because of failure to diagnose the more elusive of them, or because of technical difficulties owing to their large size. During the last few years, several syndromes have been described which are characteristic of certain of these basal tumours. The initial focal symptoms deserve special emphasis, for it is only by appreciating their significance and the importance of operating before the appearance of increasing intracranial pressure that the surgical results can be improved. It is, perhaps, unfortunate that meningiomas are characteristically quiescent tumours, for many patients, in the absence of disabling symptoms, are reluctant to consent to operation at a time when removal would be comparatively easy.

The majority of basal meningiomas lie in relation to the anterior and middle cranial fossæ; those arising on the floor of the middle fossa are less common and are not included in this paper. Subtentorial meningiomas are rare, and are quite a separate problem; they enter into the syndromes of the cerebello-pontine angle, of the foramen magnum, or, in the case of those arising from the inferior surface of the tentorium and the lateral sinus, of the cerebellar gliomas.

OLFACTORY GROOVE MENINGIOMAS

The clinical entity of the meningeal tumours which arise in the region of the cribriform plate was first described by Cushing[3] in 1927, under the name of the 'olfactory groove' tumours. He reported 5 cases of his own and collected 12 examples from the literature, one of which was described by Cleland[4], of Glasgow, in 1864. The latter were for the most part isolated case reports, many of them being unsuspected autopsy findings in patients who, on account of mental symptoms, had been confined in asylums. These tumours are attached to the dura covering the cribriform plate of the ethmoid. Occasionally, they are limited in their origin and growth to one side only. More often, however, they cover both sides of the cribriform plate, enveloping the crista galli, and are essentially midline, more or less symmetrically situated, growths.

The first manifestation of a unilateral tumour (*Fig.* 104, *c*) is anosmia on one side due to early involvement of the olfactory bulb (*Fig.* 105). As the tumour

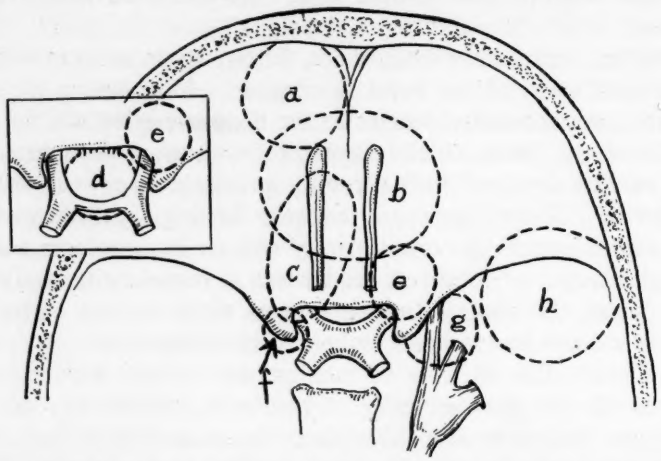


FIG. 104.—Diagram of the anterior cranial fossa to show the relative positions of the vriousa anterior basal meningiomas before they have attained a large size: *a*, Pre-olfactory; *b*, Anterior olfactory; *c*, Posterior olfactory; *d*, Tuberculum sellæ; *e*, Upper surface of lesser wing; *f*, Anterior clinoid; *g*, Inner part of sphenoid ridge; *h*, Outer part of sphenoid ridge near the pterion. The olfactory, optic, and trigeminal nerves are shown.

FIG. 105.—Excavation in the right frontal lobe due to a small unilateral olfactory groove meningioma, showing its relationship to the olfactory bulb, which is almost destroyed; an unsuspected autopsy finding in a patient who was admitted moribund from another condition.

expands it becomes deeply embedded in the frontal lobe and spreads out laterally over the orbital roof; its backward extension impinges on the upper surface of

the ipsilateral optic nerve, thus producing a primary optic atrophy with impaired vision, which is the second recognizable sign of the growth. The tumour may still be unsuspected, for a unilateral anosmia will almost certainly, and a unilateral failure of vision may, remain unnoticed or at least may not alarm the patient. Headaches and vomiting are not prominent features; and mental symptoms are variable. It is not until the tumour has reached a large size that it gives further evidence of its presence by the appearance of papillœdema in the contralateral eye, followed by secondary optic atrophy and, if untreated, complete blindness.

The more common midline tumours (*Fig.* 104, *b*), especially those extending forwards on the cribriform plate rather than backwards, produce complete anosmia as a definite and early symptom. This is followed by papillœdema in both eyes, instead of by direct pressure atrophy of one optic nerve. If the significance of the anosmia is not appreciated, the tumour usually remains unlocalized, and blindness quickly follows from secondary optic atrophy once the general intracranial pressure is sufficiently raised. In the final stages the growth reaches an enormous size, and the mental changes may be such that the patient, who is then usually blind, has to be confined in an asylum.

The characteristic combination of ophthalmic signs frequently seen with the predominantly unilateral tumours is known as the Foster Kennedy syndrome. The importance of this syndrome was first referred to by Paton[5] in 1909, and later emphasized by Foster Kennedy,[6] who reported a variety of expanding lesions in the anterior fossa, including gliomas in the lower part of the frontal lobe, and a sub-frontal meningioma which was not at that time called an olfactory groove tumour. They all presented the combination of primary optic atrophy on the side of the lesion, due to direct pressure by the tumour, and contralateral papillœdema from increasing intracranial pressure. His cases also showed an impairment of the sense of smell on the side of the tumour, but this was not included as an essential component of the syndrome, although it has become so since. It is important to note, however, that whereas the olfactory sense was usually only depressed in the glioma cases, it was completely abolished in the solitary case of meningioma. Although the olfactory groove meningiomas are generally regarded as being characterized by this syndrome, it is probable that the majority of them are midline tumours, and, as will be seen later on, have bilateral papillœdema as the only ophthalmic manifestation. The most important sign is complete anosmia on one or both sides.

The clinical syndromes evoked by the olfactory groove tumours are illustrated by the three fully recorded cases which follow.

CASE REPORTS

Case 1.—E. B., female, aged 39 years, was admitted to the National Hospital under Dr. C. P. Symonds on June 4, 1935, complaining of loss of smell and failing memory.

HISTORY.—Two years before admission the patient began to have frontal headaches which were often associated with a smarting sensation in the roof of the nose. The sense of smell, which had always been good, was completely lost eight months before admission. At about the same time she began to have occasional petit mal attacks, which consisted merely of a momentary sensation of "feeling queer"; and it was noticed that her memory was failing. During the last four months there were frequent transitory attacks of almost complete blindness, without, however, any permanent failure of vision in the intervals. Finally, one month before admission, she had a generalized convulsive attack with loss of consciousness. There was never any vomiting.

ON EXAMINATION.—The patient was an active woman with a healthy appearance, and normal in her general behaviour. A poor memory was the only evidence of mental disturbance. The sense of smell was completely absent in each nostril. Both fundi showed papillœdema of 4 dioptres. The visual acuity was 6/6 in each eye and the visual fields were full. Further examination did not disclose any abnormality.

On lumbar puncture, the cerebrospinal fluid pressure was 300 + mm. of water; the fluid contained 0·220 per cent of total protein. Radiography showed an area of dense hyperostosis (*Fig.* 106), which was thought to represent the tumour attachment on the floor of the anterior fossa, and the cribriform line had disappeared.

DIAGNOSIS.—The intracranial pressure was high, but there were no localizing signs except the complete anosmia. The assumption that the loss of smell was due to a meningeal tumour on the cribriform plate was corroborated by the hyperostosis seen in the radiograph. The anosmia was a relatively early symptom. It was unlikely, therefore, that this was one of those rare cases in which loss of smell is a false localizing sign due to high intracranial pressure (the result of a tumour in another situation), for the anosmia in such instances is a late symptom and is preceded by blindness from secondary optic atrophy. The suspected

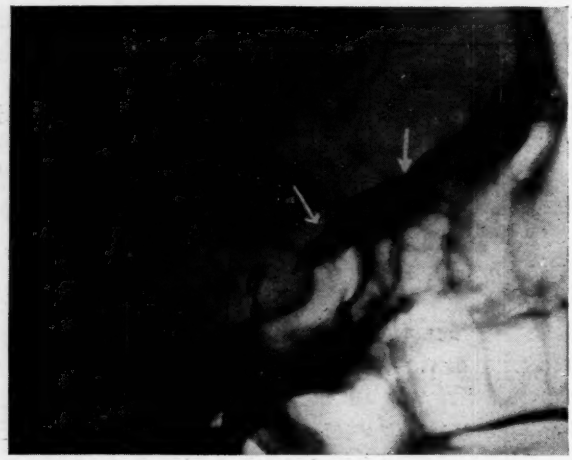


FIG. 106.—*Case* 1. Radiograph showing dense hyperostosis (between arrows) on the floor of the anterior fossa. It has a well-defined posterior margin a little in front of the tuberculum sellæ. The cribriform line has disappeared.

position of the tumour was confirmed by ventriculography, which disclosed very small lateral ventricles with complete obliteration of both anterior horns as far back as the foramina of Monro, and also backward displacement of the anterior boundary of the third ventricle. This clearly indicated a large midline basal tumour projecting upwards from the region of the cribriform plate into both frontal lobes.

OPERATION (Mr. Geoffrey Jefferson).—A right frontal bone-flap was reflected. The dura was extremely tight. When the dura had been opened, it soon became clear, from the great difficulty in elevating the frontal lobe, that it would be quite impossible to obtain sufficient access by the subfrontal approach. The brain was bulging and the ventricles were too small to afford any relief by tapping. It was then decided to uncover the left frontal lobe and approach the tumour in the midline between the two hemispheres. When the bone was cut across the midline and broken over to the left, there was a furious bleeding from the parasagittal lacunæ, which could not be controlled until the dura had been opened on the left side and the cortical veins coagulated as they crossed the subdural space to the lacunæ; the sagittal sinus was not injured.

It was intended to conclude the operation at this point as a first-stage procedure, but it was thought that the cerebral œdema which would result from the necessary interruption of so much venous drainage would raise the high intracranial pressure still more and probably prove fatal. It was decided, therefore, to provide for this by resecting a large part of the

right frontal lobe. This was done along a line passing outwards from a point on its upper border about 6 cm. behind the frontal pole. No attempt was made to remove the meningioma thus exposed. The bone-flaps were replaced and the operation concluded. She died several hours later.

AUTOPSY.—The tumour, which was the size of a tennis ball, was firmly adherent to the bone behind the crista galli. It occupied a median position and extended backwards above the sella turcica, and in front it passed deeply into the region of both olfactory grooves. Its

FIG. 107.—*Case* 1. Drawing from post-mortem photograph of the skull base showing the flat irregular hyperostosis behind the crista galli and the deep excavation of the olfactory grooves.

anterior surface was cleft by the falx, as is common with these tumours, but did not have any connection with it. The area of attachment of the tumour to the cranial base showed an extensive, irregular boss formation (*Fig.* 107). The cribriform plate was deeply excavated, and had in fact disappeared, as a probe could be passed into the nares without difficulty.

Comment.—This case illustrates some of the difficulties that may be encountered in a case with high intracranial pressure. There is no doubt that a high pressure may convert what might have been an easy and successful operation

into one of the greatest difficulty, in which the operator is led from one step to another in the attempt to solve the increasing complexity of his problem. There is little to be said in favour of decompression as an operation of choice in intracranial tumours, but the basal meningiomas are an exception. Decompression when correctly applied is an important adjunct, and may render possible the removal of a tumour that would otherwise end in disaster. *Case* 2 is an example in which success was achieved by this means in a case of exceptional original difficulty. *Case* 1, in which too high a pressure led to defeat, is worth recording, as it demonstrates the difficulties that may beset the surgeon.

The very extensive alterations in the cranial base indicate a much longer history than the two years of headache would suggest. It is fortunately very rare to find such marked changes in the bone as were discovered at autopsy, and, had the tumour been removed, it is quite possible that the patient would have succumbed to infection from the nasal passages. X-ray evidence of destruction of the cribriform plate can only be assumed to indicate an overlying meningeal tumour when there is also complete anosmia. Some observers regard a depression of the olfactory groove as the most characteristic X-ray sign of these tumours, but we believe that the essential process is one of erosion and disappearance of the bone rather than a simple depression of the groove. A similar disappearance of the cribriform line is sometimes found with other tumours, particularly gliomas low down in the frontal lobe, but in such cases the sense of smell, although very poor, is not likely to be abolished; this is an important point in differentiating the meningiomas from tumours within the frontal lobe. Absorption of the cribriform plate is also one of the late effects of long-standing increased intracranial pressure.

From the clinical standpoint, the case exemplifies the importance of complete anosmia, in a person in whom that sense had always been normal and in the absence of any nasal cause, as strong presumptive evidence of an olfactory groove meningioma, especially when X-ray examination suggests a tumour attachment in the region of the cribriform plate. The hyperostosis in this case, however, was exceptionally dense and extensive. The more usual small conical bossing which is often seen at operation, as in the next two cases, can rarely be detected with certainty in the radiograph. The localized pain in the roof of the nose was probably due to direct involvement of the nasociliary nerves where they lie on the cribriform plate.

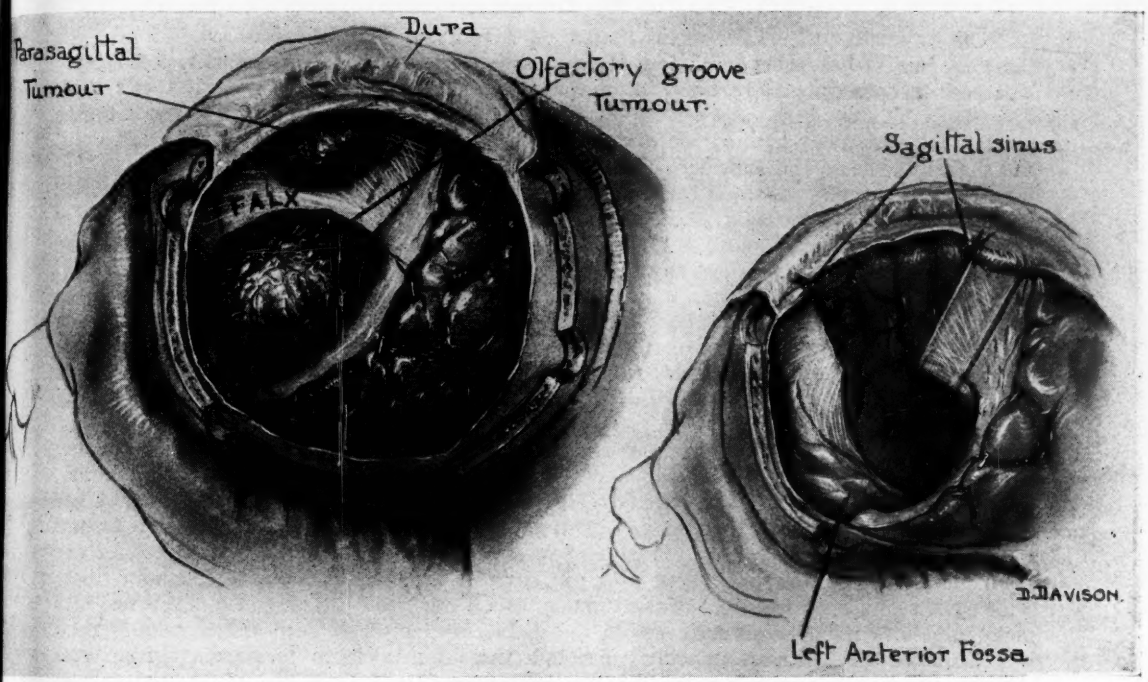
Case 2.—N. W., female, aged 32 years, was admitted to the National Hospital under Dr. C. P. Symonds on October 8, 1935. She had no particular complaint apart from recent depression, which was attributed to financial worry.

HISTORY.—Fifteen years previously she noticed difficulty in reading small print, and went to Moorfields Ophthalmic Hospital, where she was told that the left eye was blind; the right eye was normal.

Her health remained good until three years before admission, when she began to have frequent petit mal attacks; they consisted merely of a queer, dazed feeling which caused her no inconvenience and were rarely observed by others. She had noticed a slight loss of memory for about eighteen months, and during the last three months she had been unable to smell. There was never any headache or vomiting, and the vision in the right eye remained good.

ON EXAMINATION.—The patient had a very healthy appearance and there was no noticeable mental impairment. She was right-handed. The anosmia was complete on each side. The left eye was blind, with an advanced primary atrophy. The right eye had a visual acuity of 6/6 and a normal field, but showed a papillœdema of 4 dioptres. Further examination did not reveal any abnormality.

On lumbar puncture the cerebrospinal fluid pressure was 280 mm. of water; the fluid contained 0·120 per cent total protein. The lateral radiograph showed no definite abnormality of the anterior fossa; there was no detectable hyperostosis, the cribriform line was present, and there was no calcification above it. Slight erosion of the floor of the anterior fossa was, however, seen in the oblique view (Rhese position) taken to show the left optic foramen, which was normal.



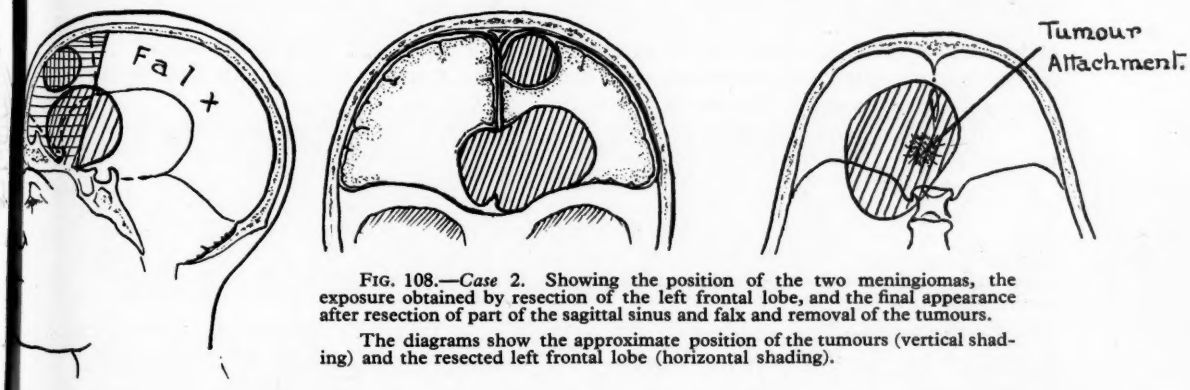


FIG. 108.—*Case* 2. Showing the position of the two meningiomas, the exposure obtained by resection of the left frontal lobe, and the final appearance after resection of part of the sagittal sinus and falx and removal of the tumours.

The diagrams show the approximate position of the tumours (vertical shading) and the resected left frontal lobe (horizontal shading).

DIAGNOSIS.—The bilateral anosmia and the left optic atrophy were the only localizing signs, and they placed the tumour in the left olfactory groove, presumably a meningioma; but the optic atrophy was known to have been present for fifteen years, the loss of smell, at least on the other side, was comparatively recent, and there were no convincing X-ray changes, for it was difficult to assess the significance of the slight erosion seen in the oblique view.

Arteriograms, which were made by injecting thorotrast into the left internal carotid, showed downward and backward displacement of the left middle cerebral vessels, thus confirming the regional diagnosis. It had to be assumed that the left optic atrophy was due to

the tumour. The meningioma might be attacked, but it had been there for at least fifteen years and was almost certainly large and firmly embedded, with considerable displacement of the base of the brain. The patient herself had no real complaint and was averse to a serious operation.

FIRST OPERATION.—A simple right subtemporal decompression was therefore made to relieve the intracranial pressure, which was already considerably raised and would soon affect the vision of the right eye. The papillœdema subsided and she returned home feeling well.

ON RE-ADMISSION.—Four months later, on March 19, 1936, she was re-admitted with the complaint of headaches for four weeks and slight failure of vision in her only seeing eye. The petit mal attacks were becoming more frequent.

On examination, the right subtemporal decompression was bulging and at times rather tense. The anosmia remained complete. Vision in the right eye was 6/6, with a full field, and the papillœdema had subsided. Otherwise there was no change.

Encephalography disclosed small ventricles, with displacement of the anterior horns and the third ventricle to the right, and a marked backward displacement of the anterior boundary of the third ventricle.

SECOND OPERATION (*Fig.* 108) by Mr. Geoffrey Jefferson.—A left frontal flap was reflected. The dura was not tight. When it was opened a small meningioma was unexpectedly seen far forwards on the surface of the cortex near the midline. The brain was separated from the tumour, which was attached to the falx just below the sagittal sinus. The bone had to be nibbled across the midline to uncover the sinus, which was then divided both behind and in front of the tumour. The falx was cut down to its lower margin and lifted out with the tumour attached.

On examining the bottom of the wound, it was seen that a much larger basal meningioma still remained, spread flatly over the floor of the anterior fossa on both sides of the midline, but occupying chiefly the left olfactory groove. This mass was quite separate from the tumour already removed. In order to obtain adequate access, a large part of the left frontal lobe was resected along a line from a point on its superior border about 7 cm. behind the frontal pole, down to a point about 2 cm. in front of the outer end of the sphenoid ridge. This gave a very good exposure of the tumour, which was about the size of a tangerine. Its main mass was removed piecemeal with the diathermy loop, and then the remaining shell was dissected free without difficulty, although there was a sharp hæmorrhage from two arteries entering it from below through the cribriform plate. The area of attachment was coagulated to kill off any tumour left behind; it was about 1 cm. in diameter, and was situated in and to the left of the midline a short distance behind the crista galli. A large cavity was exposed—most of the left anterior fossa and the mesial third of the right. The tumour had extended well backwards over the left optic foramen and the sella turcica, displacing the third ventricle backwards and to the right.

The patient stood the operation very well, but was given a blood transfusion during the later stages. One hour after its close she spoke quite normally and was greatly relieved when assured that the operation was over. She made a rapid and uneventful recovery. The only neurological change was the appearance of a slight right lower facial weakness which quickly cleared up. There was no paresis or alteration in tone of the arms or legs, no aphasia, and no grasp reflex. There was never any mental disturbance. She was discharged after three weeks feeling very well, and was able to resume her household duties immediately.*

Comment.—The successful removal of the olfactory groove tumour was facilitated by the preliminary subtemporal decompression, which is undoubtedly an important step in the management of high-pressure basal meningioma cases, and by the good exposure of the tumour obtained after resection of the left frontal lobe. The immediate provision of good access, by a clean removal of sufficient frontal lobe to uncover the tumour, makes the operation easier and safer, as it is very difficult to obtain adequate exposure by retracting the overlying cortex

* This patient was shown at the clinical meeting of the Neurological Section of the Royal Society of Medicine in February, 1937 (*Proc. Roy. Soc. Med.*, xxx, 851).

without causing considerable contusion and œdema of the brain. The resection is quickly and easily done, as the hemisphere has been reduced in thickness by the tumour bulging into it from below; it ensures better control of hæmorrhage, and reduces the risk of damaging important structures close to the deeper surface of the tumour. This procedure has been practised by several neurosurgeons both for the block removal of a lobe already partly destroyed by an infiltrating glioma within it, and for the adequate exposure of an encapsulated subfrontal tumour. Although commonly called a 'frontal lobectomy', only about half of the lobe, as delimited anatomically by the Rolandic fissure, is removed. The line of resection is, therefore, well clear of the motor area and the cortex immediately in front, more especially when exposing a meningioma, which causes more backward displacement of the surrounding brain than does an infiltrating glioma. The advantages and possible after-effects of frontal lobe removal have been discussed by Jefferson[7] in a recent report based on his experience with eight cases. He concludes that the combined frontal lobe and tumour removal, whether it be glioma or meningioma, is not only not followed by the appearance of, or the aggravation of any existing, intellectual disturbance, but often results in a disappearance of, or at least a marked amelioration in, the patient's mental symptoms. He further concludes that there is no difference between the right lobe and the left in this respect.

Clinically, this case showed the Foster Kennedy syndrome. It illustrates how slow the growth of some meningiomas may be, for it can be assumed that the tumour was the cause of the left optic atrophy fifteen years previously. The early onset, before 17 years of age, is noteworthy. It emphasizes also the importance of monocular blindness and of epilepsy beginning in adult life as possible indications of a slowly growing tumour, even when they are isolated symptoms in an otherwise healthy person.

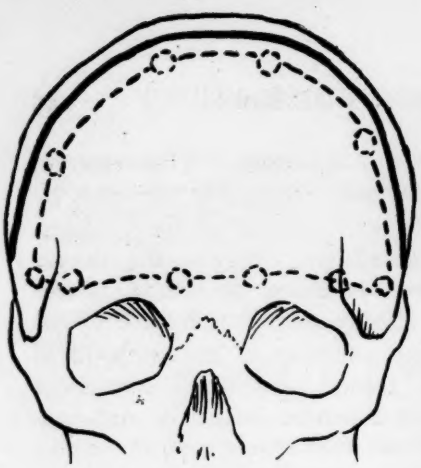
Multiple meningiomas are not uncommon, which is not surprising in view of their relationship to the numerous arachnoidal villi. The unsuspected parasagittal tumour was fortunately so situated that it was accidentally discovered and removed.

Case 3.—E. P., female, aged 38 years, was admitted to the National Hospital under Dr. F. M. R. Walshe on February 29, 1936. Her chief complaint was failing vision.

HISTORY.—Six months before admission the patient noticed a progressive failure of vision in both eyes, more especially the right. At the same time she began to have headaches, which sometimes took the form of a severe pain passing forwards from the back of the neck to the frontal region, and at other times a more prolonged bitemporal ache; they were sometimes associated with vomiting. There was no history of olfactory disturbance.

ON EXAMINATION.—The patient had a healthy appearance, a good memory, and showed no mental change apart from being unusually bright and cheerful in spite of the rapidly failing eyesight. There was complete bilateral anosmia. The visual acuity was 6/9 in the left eye, but only light perception in the right eye. The visual fields were irregularly contracted. Both fundi showed papillœdema. The right optic disc was very pale, with indistinct edges and no hæmorrhages; its appearance suggested a primary atrophy, with a superimposed papillœdema which measured 2 dioptres. The papillœdema in the left eye was more acute; it measured 5 dioptres and there were numerous hæmorrhages. The only other abnormal findings were a slight left lower facial weakness and a left extensor plantar response.

On lumbar puncture the cerebrospinal fluid pressure was 300 + mm. of water; the fluid contained 0·180 per cent total protein. Radiography showed an absence of the cribriform line, but there was no detectable hyperostosis.



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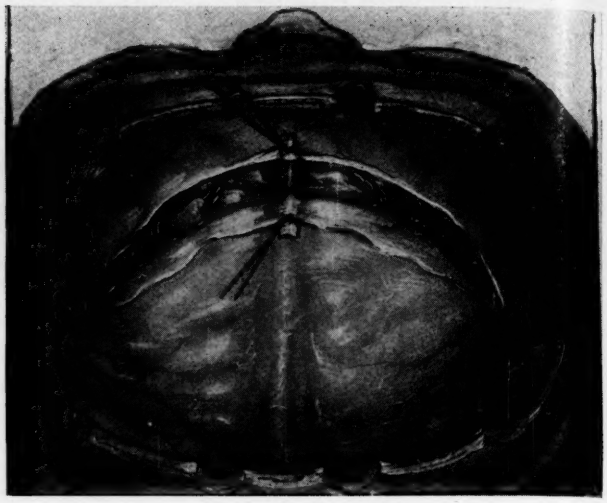

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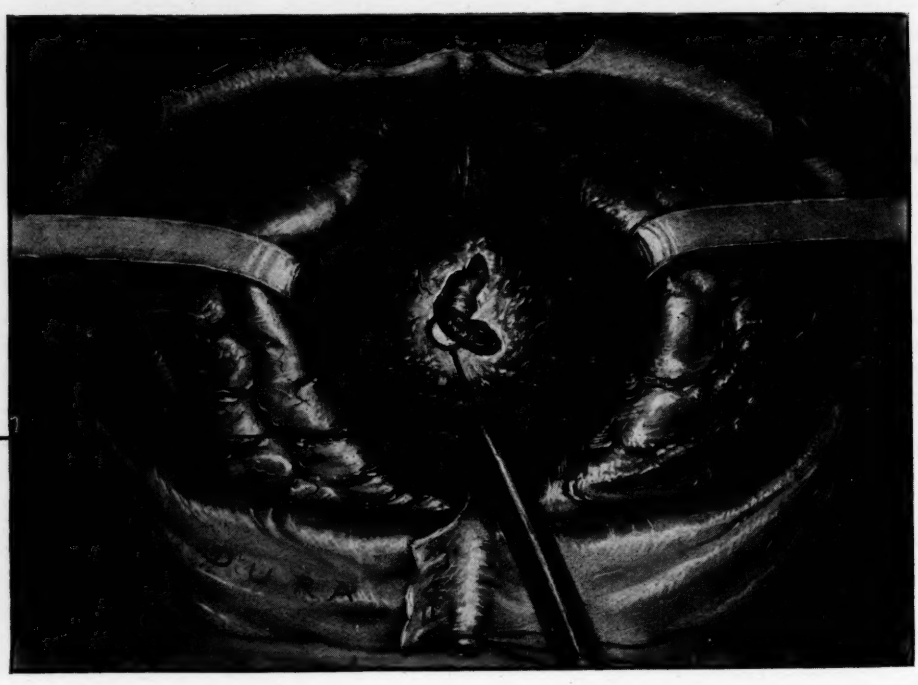

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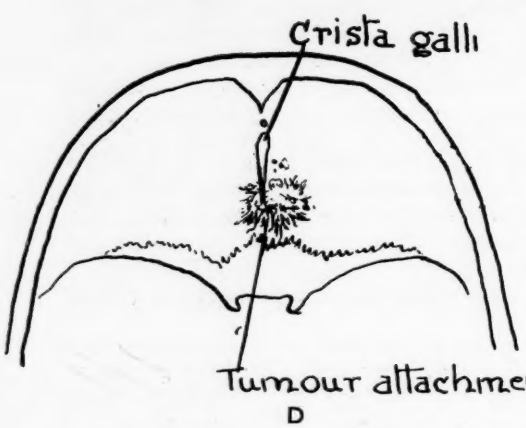

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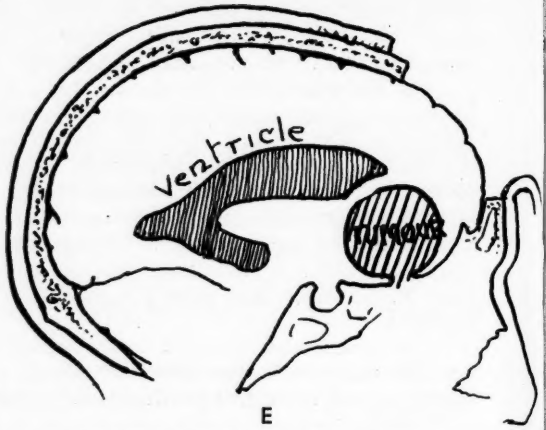


E

FIG. 109.—*Case* 3. Drawings to show the midline approach for the removal of an olfactory groove meningioma. A, The scalp incision and bone-flap; B, Reflecting the dura backwards after dividing the sagittal sinus and falx; C, Looping out the tumour between the separated frontal lobes; D, The position of the tumour attachment; E, The indentation of the anterior horns as seen in the ventriculogram, and the position of the tumour.

DIAGNOSIS.—The short history was that of increasing intracranial pressure, and the examination failed to reveal any localizing signs except complete anosmia; but she had not noticed the inability to smell, and the X-ray changes were not sufficiently definite to make a positive diagnosis of olfactory groove meningioma. This possibility, however, was supported by the evidence of direct pressure on the right optic nerve, and it was confirmed by ventriculography, which showed small lateral ventricles with both anterior horns elevated and indented from below (*Fig.* 109, E). It was decided to remove a bifrontal bone-flap and then divide the falx to allow a direct approach to the upper surface of the tumour after separating the frontal lobes.

OPERATION (Mr. Julian Taylor).—

First Stage.—A coronal incision was made just behind the hair line and the scalp reflected forwards to the supra-orbital margins. The periosteum was similarly stripped forwards as a separate layer, and then a bifrontal bone-flap, about 3 inches wide in the midline, was cut out with the Gigli saw and removed. Bleeding from several of the parasagittal lacunæ was controlled by the application of muscle grafts; the sagittal sinus was not injured. The dura was very tense. A cannula introduced through dural punctures about 2 cm. on either side of the midline encountered a firm resistance at a depth of 3 cm. on both sides. Although the patient's general condition was satisfactory, the operation was concluded as a first-stage procedure. The free bone-flap was replaced over the bulging unopened dura. She made a good recovery.

Second Stage (*Fig.* 109).—This was proceeded with one week later. The bone-flap was again removed. The dura had stretched appreciably and was considerably less tight. It was opened on each side immediately above the anterior bone edge, and the opening was completed across the midline by ligating the front end of the sagittal sinus and dividing it and the falx through to the lower edge. This allowed the sinus and falx to be drawn backwards without difficulty. A good view of the upper surface of the tumour, which was about the size of a golf ball, was then obtained by separating the frontal lobes. The tumour was gradually reduced in size by excavating its interior with the diathermy loop, and then the remaining shell was infolded and removed. Hæmorrhage from the tumour attachment was controlled temporarily by packing, and finally by diathermy coagulation of the roughened surface of a small conical boss, which was situated just behind the crista galli. The dura was laid forwards and the bone-flap replaced.

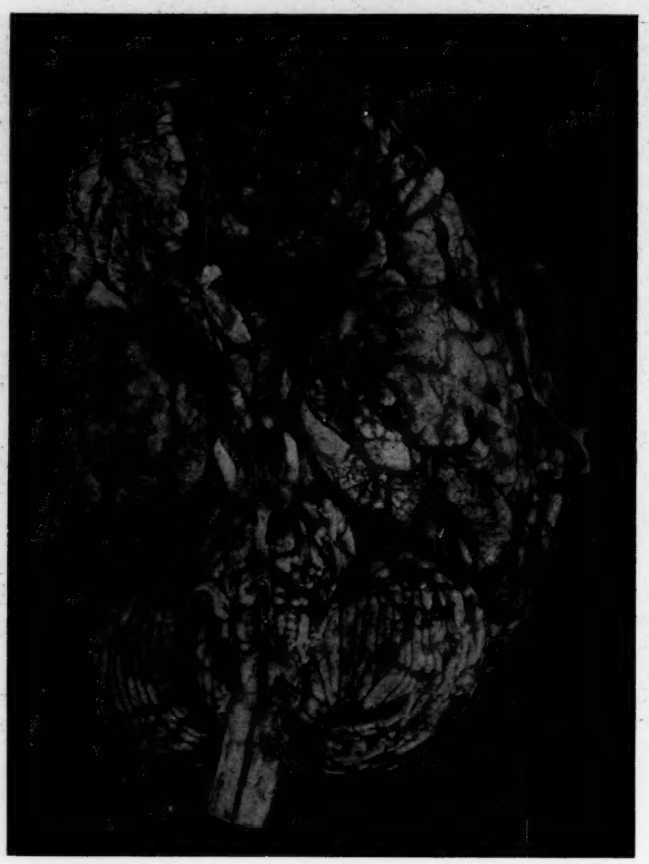
The patient made a rapid recovery. There was no mental disturbance. The headaches were relieved, the papillœdema subsided, the weakness of the face disappeared, and the plantar response became flexor. The visual acuity remained unchanged. She returned home in 3½ weeks, feeling and looking very well.

The shell of the tumour and the many small pieces removed with the loop together weighed 44 g.

Comment.—The midline intradural approach to a subfrontal tumour, after the removal of a completely free bone-flap and separation of the frontal lobes, was an innovation which proved very successful. The access was good and there was no evidence of disturbed frontal lobe function afterwards. The slight stretching of the unopened dura, when the bone-flap is large enough, has a definite decompressive effect, particularly when dealing with meningiomas, as the increased pressure in these cases is due much more to the size of the tumour than to obstructive hydrocephalus. This partial relief of tension contributes to the beneficial effect of the two-stage flap operation, which is still occasionally resorted to, when excessive hæmorrhage is anticipated, in the removal of the more accessible meningiomas under the vault, though it has become less often necessary since the introduction of diathermy.

CLINICAL MANIFESTATIONS OF THE OLFACTORY GROOVE MENINGIOMAS

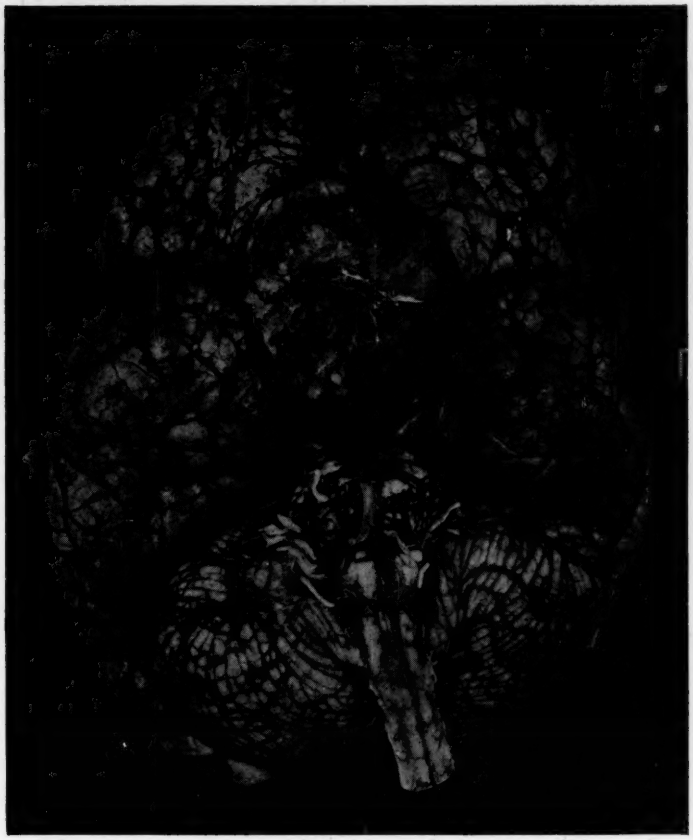
Twelve cases (including the three already described) are available from the records of the Hospital within recent years for summarizing the symptomatology



A

B

FIG. 110.—Anterior olfactory groove meningioma: A, Viewed from the basal aspect of the brain; and B, On sagittal section of the brain. The tumour, partly detached, is situated well in front of the optic nerves. The patient had complete anosmia and bilateral papillœdema.



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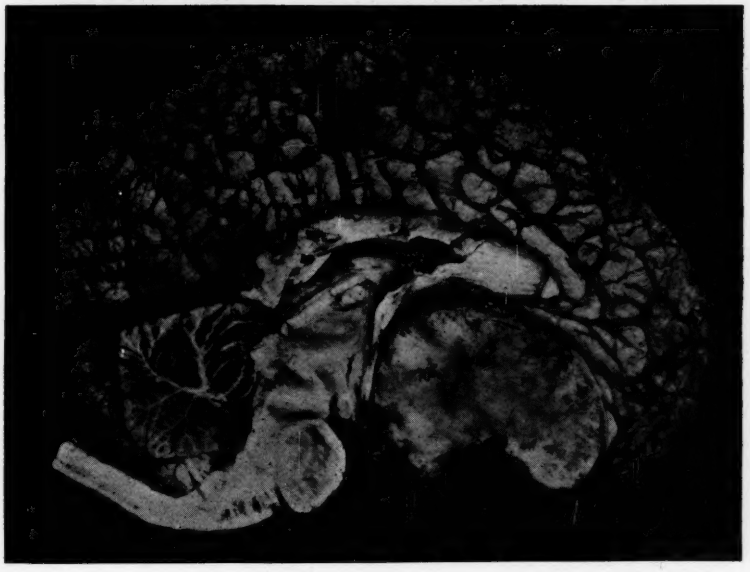

B

FIG. 111.—Posterior olfactory groove meningioma: A, Viewed from the basal aspect of the brain; and B, On sagittal section of the brain. The tumour has extended backwards above the sella and has directly implicated the optic nerves and chiasm. The patient had complete anosmia, bitemporal hemianopia, and primary optic atrophy. Compare with *Figs.* 110 and 113.

of these tumours. A study of the cases has shown that they can be readily divided, on a basis of the ophthalmic signs, into two groups: (1) Those with tumours situated more anteriorly (*Fig.* 110) in the cribriform plate (8 cases), as exemplified by *Case* 1; and (2) Those with tumours extending more posteriorly (*Fig.* 111) so as to implicate directly one or both optic nerves (4 cases), of which *Case* 2 is an example.

Anosmia.—In the anterior group, only 1 patient showed considerable mental change and was unable to give an adequate history or co-operate in the examination. Five of the remaining 7 patients gave a definite history of complete anosmia as an initial symptom for periods varying from four months to four years (average one to two years) before any visual impairment was observed. The remaining 2 patients were found to have a complete anosmia that had not been noticed before the examination; in one of them the sense of smell was thought to be good, and at autopsy the tumour was found to be predominantly unilateral, so that the involvement of the contralateral olfactory nerve was probably very recent. In all of these anterior cases the anosmia was bilateral.

Of the 4 patients in the posterior group, only 1 had anosmia as the initial symptom (followed by bitemporal hemianopia). Two patients, who had not noticed any impairment, were found to have anosmia on one side and a considerable loss on the other; a more advanced stage of this was shown by the fourth patient (*Case* 2), who complained of recent anosmia (following monocular blindness of many years' duration).

Of the 11 patients who could be examined adequately, therefore, 7 had complained of loss of smell, and examination showed a bilateral anosmia in 9 and a unilateral anosmia in the other 2 cases. Elsberg,[8] in a recent report of 15 cases, particularly from the standpoint of their early recognition by the discovery of slight depression of the sense of smell, found that only 5 had observed olfactory impairment, and that while examination showed definite impairment in 14, it had become complete in only 9. None of our cases complained of olfactory hallucinations preceding the loss of smell; it was noted in 5 of Elsberg's cases.

Failing Vision.—All the patients in the anterior group complained of recent transient attacks of mistiness or blindness (black-outs), and usually also progressive failure of vision. They all had papillœdema in both eyes, with a varying degree of secondary atrophy and visual failure. In one instance (*Case* 3) the appearance of one optic disc suggested a recent papillœdema superimposed on a primary optic atrophy.

In 3 of the 4 patients belonging to the posterior group, vision had failed in one eye many years previously (9, 10, and 15 years), due presumably to direct pressure on the optic nerve by a predominantly unilateral tumour; in two of them the contralateral eye showed a recent temporal hemianopia with primary atrophy, but in the third (*Case* 2) there was papillœdema. In the fourth case, complete anosmia was followed after a short interval by the appearance of bitemporal hemianopia and bilateral optic atrophy.

The combination of primary optic atrophy and contralateral papillœdema was present in only 2 of the 12 cases. The infrequency of the Foster Kennedy syndrome in the series at the National Hospital calls for special comment, as it has been generally supposed that the majority of olfactory groove meningiomas are characterized by this clinical picture. This belief is probably explained by the fact that

the few reports concerning these tumours are from neurosurgical clinics, to which cases with this unmistakable syndrome are more likely to be referred. It was present in most of the 9 cases reported by Olivecrona and Urban.[9] Although the syndrome might not be expected so frequently in a neurological hospital, its occurrence in only 2 of the 12 cases in the present series was surprising. This fact emphasizes the importance of distinguishing what may be termed the 'anterior olfactory' from the 'posterior olfactory' syndrome, and of making a correct interpretation of anosmia when it is the only localizing sign.

Headache.—This was a fairly prominent complaint of all patients in the anterior group. It usually began coincidentally with the visual failure, i.e., some time after the anosmia, and presumably was due to the increasing intracranial pressure. In 2 cases, each with marked hyperostosis at the tumour origin, the headache had been present for some considerable time before the anosmia; in *Case* 1 this early headache was a severe and outstanding symptom. It was usually generalized or frontal in distribution; it may be noted, however, that in 3 instances there was marked suboccipital pain and neck stiffness. Headache was an inconspicuous symptom in the posterior group; it was present in a mild degree in only 1 case.

Mental Changes.—In only 1 of the 12 patients was mental deterioration and drowsiness such an outstanding feature as to make co-operation impossible. Five patients complained of recent failure of memory, 2 others were considered to be euphoric, and the remaining 4 showed no obvious change. Marked mental deterioration is less likely to occur when the frontal lobes are compressed by a meningioma (and rarely does so before the patient is blind) than when there is destruction of neural tissue by an invasive glioma.

Pyramidal Signs.—In spite of the large size which the anterior tumours may attain, only 4 of them had produced slight pyramidal signs, which consisted of nothing more than a lower facial weakness and usually an extensor plantar response and diminished abdominal reflexes. Only 1 case had bilateral extensor plantar responses. A tendency to a grasp reflex was observed in 3 instances; in 1 of them it was bilateral. Only 1 of the cases in the posterior group showed pyramidal signs with a slight weakness of one arm and leg.

Epilepsy.—Three of the 12 cases had petit mal attacks or occasional loss of consciousness without focal phenomena. None gave a history suggesting uncinate attacks.

Vomiting.—This occurred in only 2 of the 12 cases, both in the anterior group. It was a very late symptom, and accompanied the more severe pressure headache.

Radiographic Changes.—The most constant sign was a disappearance of the cribriform line, which, however, can only be regarded as confirmatory evidence of a meningioma when there is also anosmia. There may be a small boss of mottled calcification at the tumour attachment, but a marked hyperostosis is very unusual, and calcification within the tumour is rare. In many cases there is no X-ray evidence of the tumour.

SUMMARY

The syndromes of the olfactory groove meningiomas may be summarized as follows: In the anterior group the first symptom is complete (bilateral) anosmia,

which antedates the headaches and is usually of from one to two year's duration. This may be followed by slight failure of memory, but mental deterioration is uncommon before the terminal stages with blindness. Finally, there are recent (six months or less) symptoms of increasing intracranial pressure, such as headache and transient blindness. Examination reveals complete anosmia and bilateral papillœdema.

The less common tumours, which extend backwards from the posterior part of the olfactory groove, show a different syndrome. The first sign, as the tumour is usually to one side of the midline, was the discovery of loss of vision in one eye many years (9 to 15 years) previously. Then, after a long quiescent period, there is progressive visual failure (during 1 to 3 years) in the contralateral eye, due either to direct pressure on the nerve or secondary to papillœdema. When examined the patient is found to have primary atrophy in one or both eyes and unilateral anosmia, with a slight sense of smell usually remaining on the contralateral side.

Headache and other signs of increasing intracranial pressure occur late in the clinical history of olfactory groove meningiomas, and, in the majority of cases, it is not until this appears that the cause of the unexplained monocular blindness or anosmia becomes apparent. This shows the importance, as will be emphasized again with the tumours of the inner end of the sphenoid ridge, of making a careful study of cases with obscure defects of vision.

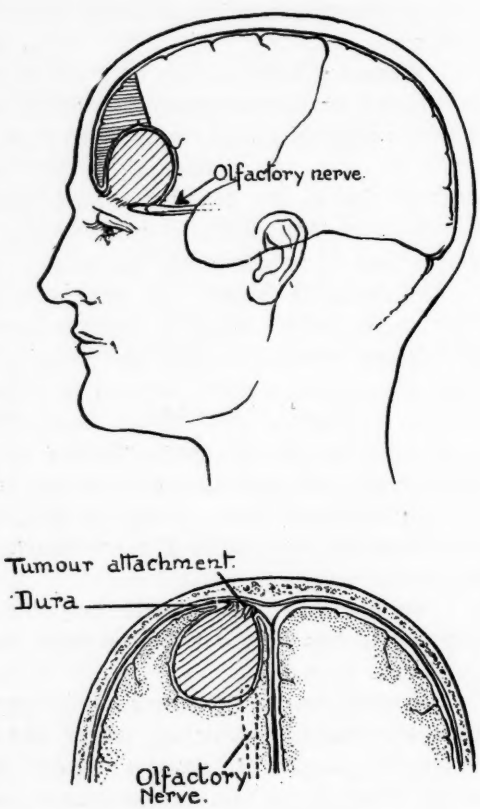

FIG. 112.—Diagrams showing the position and attachment of a pre-olfactory meningioma and its relationship to the olfactory bulb. The resected cortex is shaded.

PRE-OLFACTORY MENINGIOMAS

Meningiomas occasionally arise farther forwards on the floor of the anterior fossa, where there is still sufficient room for a large tumour to produce symptoms of increasing intracranial pressure without destroying the olfactory bulb. The sense of smell may be regarded as normal, or, if only the anterior end of the olfactory bulb is compressed, it may be partially lost on one side, but there is no complete anosmia. These tumours lie in the anterior corner of the fossa, buried under the frontal lobe, and are not likely to be localized clinically unless the radiograph shows changes in the bone just behind the lower part of the frontal air sinus. They may be termed 'pre-olfactory' tumours (*see Fig.* 104, *a*).

We have observed two cases; the position of the tumour in one of them is shown diagrammatically in *Fig.* 112. There was a history of symptoms of increasing

intracranial pressure, with lassitude and failing memory for six months. The only important positive signs were bilateral papillœdema of 3 dioptres and slight mental changes; the sense of smell was good on both sides, although possibly a little weaker on the left. The tumour was localized by ventriculography, and a 60-g. meningioma was successfully removed from under the frontal lobe after excising a narrow rim of cortex. The tumour was attached to the dura in the anterior corner of the fossa, where the orbital roof joins the posterior wall of the frontal air sinus.

OTHER TUMOURS WITH OLFACTORY DISTURBANCES

Meningiomas situated behind the posterior olfactory group may also produce an impairment of the sense of smell through displacement and stretching of the olfactory nerves; the loss of smell, however, is not likely to be so complete as when it is due to compression of the olfactory bulb by a meningioma farther forwards. Those in the midline (tuberculum sellæ meningiomas) are usually recognized when comparatively small owing to the early loss of vision in both eyes, so that the olfactory nerves are only slightly displaced and there is little or no impairment of function. Tumours on one side, however, i.e., on the upper surface of the lesser wing of the sphenoid, more often reach a large size, as the vision of only one eye is affected, and the greater stretching of the olfactory nerve results in a severe impairment of smell.

It may be noted that gliomas which involve the olfactory pathways within the brain, especially in the region of the uncus, frequently produce a considerable depression of the sense of smell on the same side. Hallucinations of smell also occur quite commonly when the uncus is infiltrated by a deep glioma, but it is a rare and late symptom of external compression by an encapsulated tumour situated in the Sylvian cleft or in the interpeduncular region (e.g., meningioma, pituitary adenoma, or hypophysial duct tumour).

MENINGIOMAS OF THE TUBERCULUM SELLÆ

A critical study of the symptomatology of these tumours was first made by Holmes and Sargent[10] in 1927. They described 10 cases and discussed the main points in the differential diagnosis between them and intrasellar and other suprasellar tumours. Cushing and Eisenhardt,[11] in 1929, reported a series of 15 cases, and amplified their characteristic syndrome—namely, bilateral primary optic atrophy in a middle-aged person, with progressive failure of vision and bitemporal field defects, combined with a normal sella turcica.

These midline tumours are attached to the tuberculum sellæ between the optic foramina (*see Fig.* 104, *d*). The optic nerves are compressed and the chiasm is pushed backwards and stretched by the tumour, which occupies the prechiasmal space. Before the growth has attained a large size, therefore (and the operable tumours rarely weigh more than 15 g.), it has produced bitemporal hemianopia and primary atrophy, like other midline tumours in this region. Headaches or other symptoms are uncommon, and there are no other objective signs. This is the characteristic syndrome when the tumour is no larger than a walnut (*Fig.* 113), and surgical removal should be undertaken at this stage, before the optic nerves have been irreparably damaged. With the further growth of the tumour, the syndrome becomes obscured by the appearance of late signs such as total blindness, olfactory impairment, mental

changes, and definite flattening of the sella from above. Finally signs of increased intracranial pressure such as headaches, vomiting, and drowsiness, resulting from occlusion of the foramina of Monro, indicate that the time for operation has passed.

The bitemporal hemianopia is rarely symmetrical. The more seriously affected eye may be almost or quite blind when the patient first comes under observation, probably because the origin of the tumour has been nearer to one optic foramen. In such cases it is important to establish the bitemporal nature of the hemianopia,

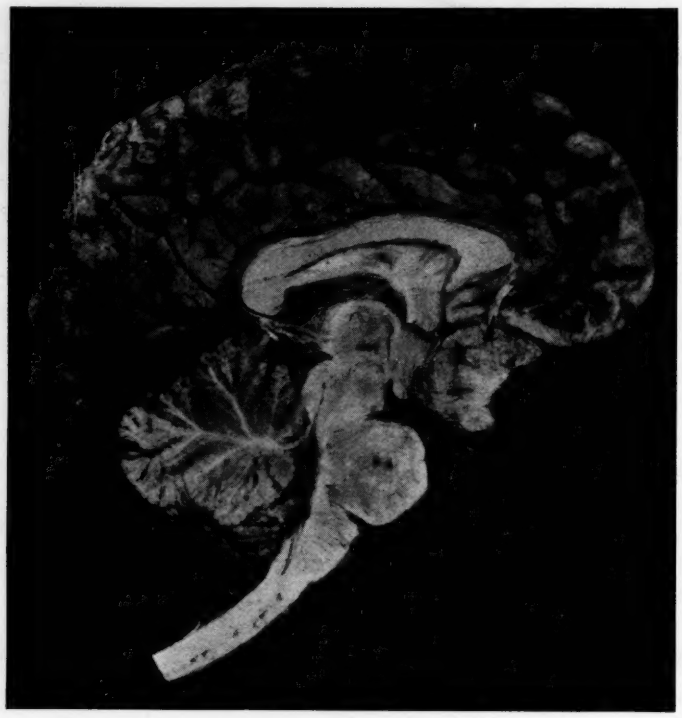

FIG. 113.—Sagittal section of the brain, showing a meningioma of the tuberculum sellæ. The patient had bitemporal hemianopia and primary atrophy, but no loss of smell. Note its relatively small size in comparison with the posterior olfactory groove tumour in *Fig.* 111, B. (*From Holmes and Sargent.*)

either from a clear history of its onset in the blind eye, or from perimetric examination of such vision as remains, in order to exclude the possibility of a tumour arising from the inner part of the sphenoid ridge (which usually produces monocular blindness followed by temporal hemianopia in the other eye). This is important when deciding on which side the tumour should be approached, particularly if the surgeon is accustomed to explore tuberculum sellæ meningiomas on the side of the less affected eye.

This brief description of the tuberculum sellæ syndrome has been included to complete, from the pathological standpoint, the tumours which arise from the anterior basal meninges. They really belong, however, to the group of tumours in relation to the sella turcica, from some of which (e.g., suprasellar pituitary adenoma, hypophysial duct tumours) it may be impossible to distinguish them clinically. Also, the surgical problems met with in the removal of these relatively

small tumours, e.g., the method of approach, the dangerous proximity of the optic nerves, etc., are similar to those which are encountered in operations for pituitary tumours, and are quite different from those of the much larger olfactory groove and sphenoid ridge meningiomas. It is unnecessary, therefore, to describe a case in detail, but it is desirable, in view of their situation, to summarize the clinical features, because they show a gradual transition into the posterior olfactory tumours in front and the inner sphenoid ridge tumours at the side.

There have been 13 cases at the National Hospital within recent years, since the publication of the paper by Holmes and Sargent. They all conform to the syndrome of bilateral primary atrophy and bitemporal hemianopia. There was monocular blindness in 7 of them, and only light perception in the more seriously affected eye in 3 others, but the median position of the tumour in these cases was known from the history of progressive bitemporal hemianopia. Five of the 13 cases had complained of slight headache, but this was never severe. None of them showed any loss of the sense of smell or other neighbourhood signs; they are thus distinguished from the much larger posterior olfactory groove tumours which arise very little farther forward. The dorsum sellæ is sometimes shortened and flattened from above, which is the only common X-ray evidence of these tumours; the sella is usually normal in size, and calcification within the tumour or hyperostosis at its attachment is exceptional.

The following case illustrates how the method of bifrontal approach, as described in *Case* 3, may sometimes be useful for a deep midline tumour, such as a suprasellar meningioma. The case is also of interest in relation to the question of the correct approach to one of these tumours with reference to the better seeing eye.

A woman of 32 years gave a history of progressive bitemporal hemianopia of twelve months' duration, with transient exacerbations of the visual impairment during menstruation. On examination, the patient was found to be nearly blind, and showed marked primary optic atrophy. Vision was reduced to $\frac{1}{60}$ in the left eye and blindness in the right eye. The sella was only very slightly enlarged. The clinical diagnosis was a suprasellar tumour, but the uncertainty regarding its type, whether pituitary adenoma or tuberculum sellæ meningioma, made it difficult to decide on which side to operate.

When a meningioma is approached on the side of the more seriously affected eye, in a patient who is nearly blind, there is a risk that even a slight disturbance to the better functioning optic nerve (which may be partly embedded in the tumour and does not come into view until most of the tumour has been removed) will destroy what little vision remains; it is regarded as important, therefore, that these tumours should be approached on the side of the better seeing eye in order that the optic nerve may be identified and protected whilst the tumour is being removed. With the pituitary adenomas, on the other hand, the optic nerves are more cleanly displaced and more easily seen, so that the side of operation is of less importance; and a right-handed surgeon generally finds it more convenient to operate on the right side, irrespective of which is the less affected eye.

The tumour was assumed to be a pituitary adenoma because of the history of exacerbations of the visual impairment during menstruation, and Mr. Jefferson, therefore, made a transfrontal exploration on the right side. When the tumour was seen to be a meningioma, the approach was modified, in order to bring the left

optic nerve into view, by reflecting a corresponding left frontal flap, dividing the sagittal sinus and falx, and elevating the separated frontal lobes. The complete removal of the tumour was followed by a considerable recovery of vision in both eyes.

It was found that the attempt to preserve the olfactory nerves, which passed backwards across the upper surface of the growth, made the dissection of the tumour around the underlying optic nerves more difficult. The olfactory nerves finally snapped across, and further experience may show that the other advantages of this approach are outweighed by the disadvantages of complete anosmia. This operation is likely to prove more useful for the larger olfactory groove tumours that have already destroyed the olfactory bulbs.

SPHENOID RIDGE MENINGIOMAS

The meningiomas which are related to the sphenoid ridge show a natural division into two groups: (1) Those attached to its inner part, which is formed by the lesser wing of the sphenoid; and (2) Those attached to the outer part of the ridge. The clinical features of the two groups are quite different. Tumours on the inner part of the ridge have a well-defined syndrome related to early involvement of one optic nerve, whereas tumours on the outer part of the ridge attain a large size and produce symptoms of increasing intracranial pressure without focal manifestations.

1. THE INNER SPHENOID RIDGE GROUP

The common sites of origin of the tumours which are conveniently included in this group, also frequently called the lesser wing tumours, are shown diagrammatically in *Fig.* 104. They all arise close to the optic nerve, and early optic atrophy is the outstanding clinical sign and may remain for a long time the only manifestation of the growth. A tumour arising, for example, from the anterior clinoid process (*Fig.* 104, *f*) immediately impinges on the outer side of the adjacent optic nerve, and unilateral blindness ensues while the growth is still small. When the origin is on the upper surface of the lesser wing (*Fig.* 104, *e*), which is a common site, the tumour lies in the anterior fossa and is likely to have attained a greater size before it impinges on the upper surface of the optic nerve. A tumour attached to the edge or the lower aspect of the lesser wing (*Fig.* 104, *g*), on the other hand, is closely related to the superior orbital fissure and may be expected to produce early involvement of the oculomotor and trigeminal nerves, in addition to the optic nerve. The characteristic syndrome of this group, therefore, is unilateral primary optic atrophy and progressive encroachment on the visual field of the same eye, before the growth is large enough to affect neighbouring structures or to increase the intracranial pressure. Elsberg and Dyke[12] have recently reported a group of 4 such cases in which the diagnosis, suspected on clinical grounds, was confirmed by encephalography, which demonstrated changes in the shape of the interpeduncular cistern which they now regard as characteristic. As a result of this, operation was undertaken with confidence before the appearance of other signs or involvement of the contralateral eye, and small tumours weighing not more than 12 g. were successfully removed; in one case the tumour weighed "little more than 1 g.".

If the isolated progressive failure of vision in one eye is disregarded, there is a considerable latent period, during which the tumour is quietly growing to a large

size. Later on, additional signs appear, such as failing vision in the other eye, oculomotor palsies, impairment of the sense of smell, disturbances of sensation over the face, and increasing intracranial pressure, as in some of the patients in the series reported by Alpers and Groff,[13] and Groff.[14] The larger tumours have usually acquired an extensive attachment to the sphenoid ridge, spreading along to the greater wing and surrounding the superior orbital fissure; they lie across the inner half of the ridge and extend forwards along the floor of the anterior fossa and

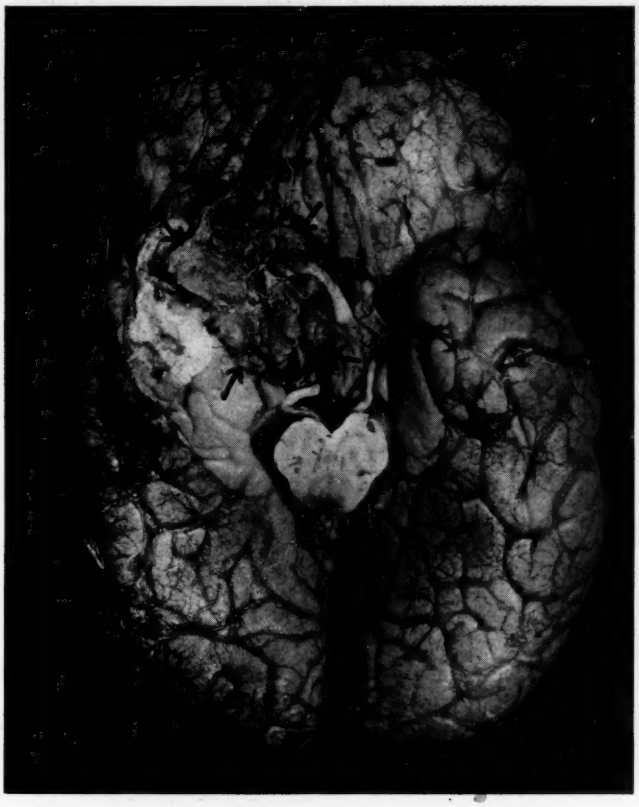

FIG. 114.—Inferior surface of the brain with a large meningioma of the inner sphenoid ridge group, showing involvement of the right olfactory and right optic nerves, and the extension of the tumour into the middle fossa displacing the temporal lobe backwards. The patient had right anosmia, right primary optic atrophy, papilloedema in the left eye, and slight left pyramidal signs, and a radiograph showed absence of the right anterior clinoid process.

backwards into the middle fossa. The relationship of a large tumour to the base of the brain is shown in *Fig.* 114.

The essential syndrome of these tumours is illustrated by the following two case reports. They serve to emphasize the fact that although the growth is revealed at an early stage by progressive failure of vision in one eye, it often reaches an enormous size, and may become inoperable before causing any serious disability. In *Case* 4 the bulk of the tumour was above the sphenoid ridge in the anterior fossa, whereas in *Case* 5 it lay mainly behind the ridge in the middle fossa.

Case Reports

Case 4.—H. E., female, aged 45 years, was admitted to the National Hospital under Dr. Purdon Martin on February 12, 1936, with the complaint of loss of vision in the right eye and headaches.

History.—Three years previously the patient first noticed an increasing mistiness in the right eye, and she also began to suffer from right frontal headaches. The visual impairment progressed, without any noticeable hemianopic defect, until the right eye became blind eight months before admission. The left eye was not affected. She had a generalized seizure with loss of consciousness six weeks before admission.

On Examination.—She was a healthy looking woman without any evidence of mental disturbance. The sense of smell was very poor on the right side, but was normal on the left. The optic disc of the blind right eye showed primary atrophy. The left eye had an acuity

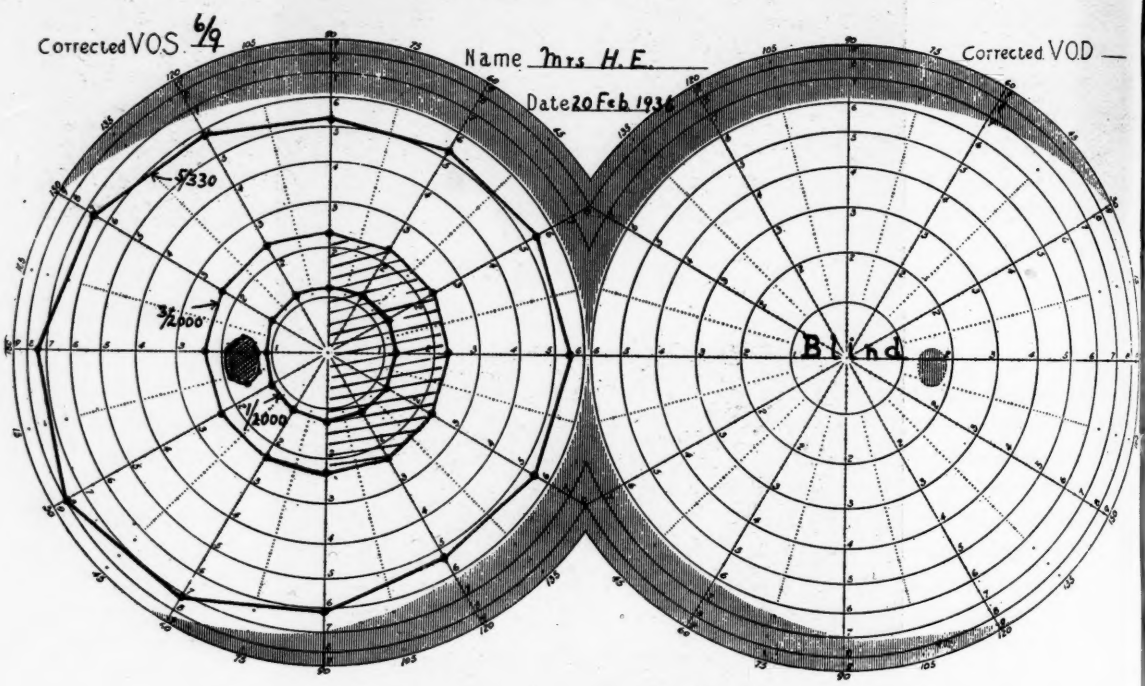

Fig. 115.—*Case* 4. Fields of vision before operation, showing blindness of the right eye and haziness (shaded) in the nasal field of the left eye.

of 6/9, but there was a marked haziness in the nasal half of the visual field (*Fig.* 115), and the optic disc was obscured by an early papillœdema of 2 dioptres. The right pupil was fixed to direct light, but reacted briskly on consensual stimulation; the left pupil was normal. There were no ocular palsies and no proptosis. Further examination did not reveal any abnormality except bilateral extensor plantar responses.

On lumbar puncture the cerebrospinal fluid pressure was 95 mm. of water; the fluid contained 0·190 per cent total protein. Radiography showed a well-marked conical hyperostosis (*Fig.* 116) just in front of the right anterior clinoid process, which was considerably eroded. The special view for the right optic foramen showed that the hyperostosis overlay the optic canal without narrowing it (*Fig.* 117).

Diagnosis.—The clinical features centred around the Foster Kennedy syndrome and resembled those of a right olfactory groove meningioma, except that the loss of smell on the right side was not quite complete. The radiograph, however, showed the tumour attachment on the superior surface of the lesser wing of the sphenoid. This more posterior situation accounted for the incomplete loss of smell, and the tumour probably extended well back over

the sphenoid ridge into the middle fossa. It was decided, therefore, to reflect a right frontal flap suitable for a frontal lobe resection if required.

OPERATION (*Fig.* 118) by Mr. Geoffrey Jefferson.—A right frontal bone-flap was reflected. On elevating the frontal lobe a basal meningioma was at once encountered, but in order to

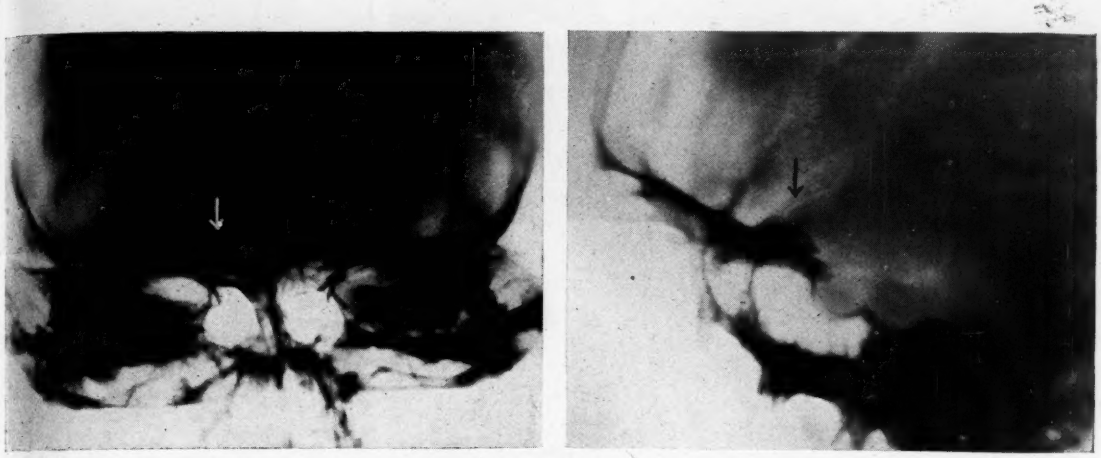

FIG. 116.—*Case* 4. Radiographs (postero-anterior and lateral) showing the conical hyperostosis on the upper surface of the lesser wing, at the base of the right anterior clinoid process.

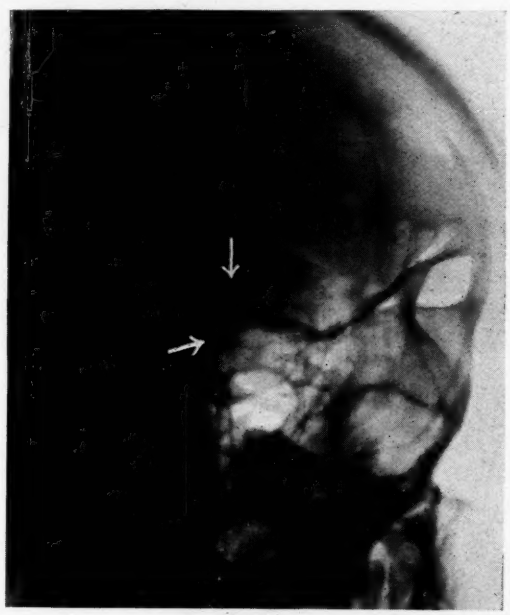

FIG. 117.—*Case* 4. Radiograph taken obliquely (Rhese position) through the right orbit to show the optic canal. The canal is normal in size and has not been constricted by the hyperostosis on its roof.

obtain adequate access, it was clearly necessary to resect a large part of the right frontal lobe. The resection was made along a line just in front of the sphenoid ridge. This uncovered the front half of a very vascular tumour, which was about the size of a tangerine. It extended forwards to cover most of the orbital roof and also projected backwards over the inner two-thirds of the sphenoid ridge into the middle fossa.

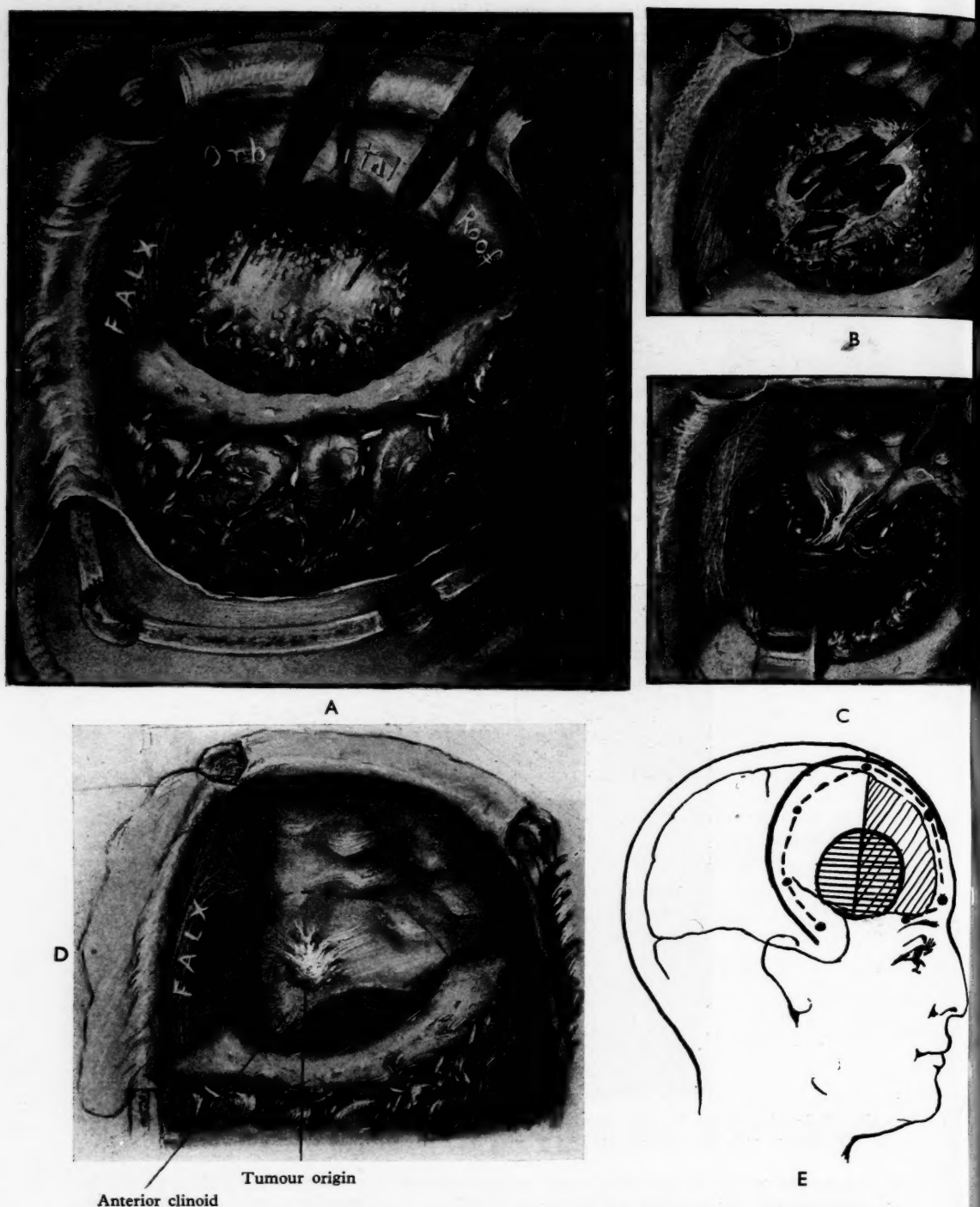

FIG. 118.—*Case* 4. Drawings to show the stages in the removal of a large vascular meningioma growing from the upper surface of the lesser wing. A, Bipolar coagulation of the tumour which was exposed after resection of the frontal lobe; B, Excavating the hardened tumour with the diathermy loop; C, Separating the final shell of tumour from its attachment; D, The empty anterior fossa showing the tumour origin and the eroded anterior clinoid; E, Diagram showing the tumour (horizontal shading) and the resected frontal lobe (oblique shading).

A preliminary attempt was made to remove the tumour intact, but it was found to be much too large and firmly anchored to dislodge and lift out in one piece without considerable risk. Its volume had to be reduced by excavation with the diathermy loop. When this was tried, however, there was so much bleeding from the tumour substance that it was necessary to resort to bipolar coagulation. Two needles, attached to the two poles of the diathermy apparatus, were plunged into the tumour at different points and coagulation carried out, the heat generated being kept within bounds by the application of cool saline. By this means the central part of the tumour was hardened, and was then easily removed with the cutting loop; the coagulation had to be reverted to several times to reduce bleeding from the deeper untreated portions. When the bulk of the tumour had been removed in this manner, the posterior part of the remaining shell could be drawn forwards and separated from the cerebral tissue under vision, thus avoiding the danger of injuring the cerebral vessels in contact with its buried surface. The front of the tumour was then pulled backwards and finally separated

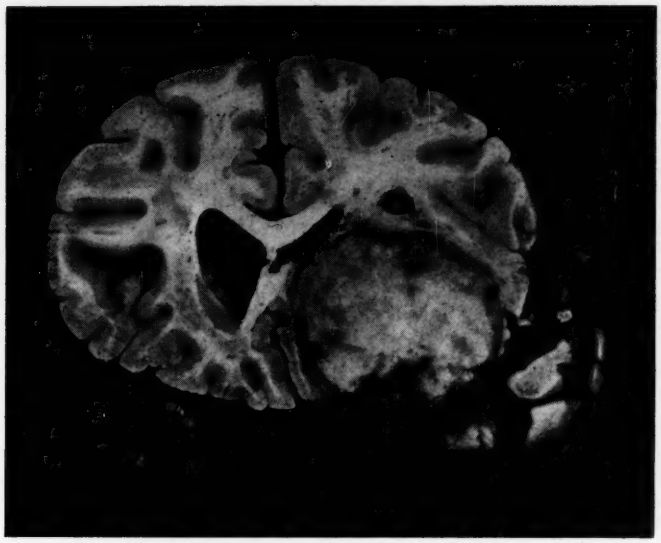

FIG. 119.—Coronal section of the brain (immediately in front of the optic nerves) showing a meningioma that was similar in position and size to the tumour in *Case* 4. It was attached to a conical hyperostosis on the upper surface of the lesser wing.

from its attachment to the boss of bone. The mesial part of the tumour crossed the midline under the falx, above the sella turcica and the left anterior clinoid, and was partly buried in the left hemisphere. This extension was separated after further excavation, until finally the whole mass could be dislodged and withdrawn. The bony boss was thoroughly coagulated to destroy any remaining tumour cells. The tumour bed extended backwards at least 2 cm. behind the anterior clinoid. A transfusion of blood was given during the later stages of the operation, at the conclusion of which the patient's general condition was very satisfactory.

POST-OPERATIVE COURSE.—An immediate slight left hemiparesis cleared up within 24 hours. There was a moderate polydipsia and a pyrexia of 101°–103° for about ten days, both of which were probably due to a disturbance of the central controlling mechanism, for the tumour had extended far back and caused considerable displacement of the basal ganglia; the cerebrospinal fluid was clear and sterile. The cerebral displacement caused by a similar tumour is shown in *Fig.* 119.

The patient made a good recovery and was better than she had been for years past. The relative nasal hemianopia disappeared, and examination showed no abnormal signs except for the persistent blindness in the right eye and complete anosmia on the right side. She resumed full household duties and continues to lead her normal life.

The fragments of tumour, including the final shell, which measured 5 cm. in diameter, weighed 80 g.

Comment.—The attachment of a large basal meningioma is so inaccessible that it is impossible to remove the tumour intact, or to reduce its vascularity by controlling the dural supply early in the operation. The well-known procedure of excavating the tumour piecemeal and then separating the remaining shell from the surrounding brain, has long been used for removing large, deep tumours from below the brain. The introduction of the diathermy loop enabled this excavation, previously a long and tedious process, to be done more quickly and with much less bleeding (*Fig.* 120). Preliminary bipolar coagulation, as advocated by Olivecrona and Urban,[9] is a most effective method of further reducing bleeding from excessively vascular tumours. The coagulation must be done in layers to avoid the danger of piercing the deep surface of the tumour and injuring the brain tissues beyond, and the proximity of the two terminals within the tumour requires good access to prevent their accidental contact.

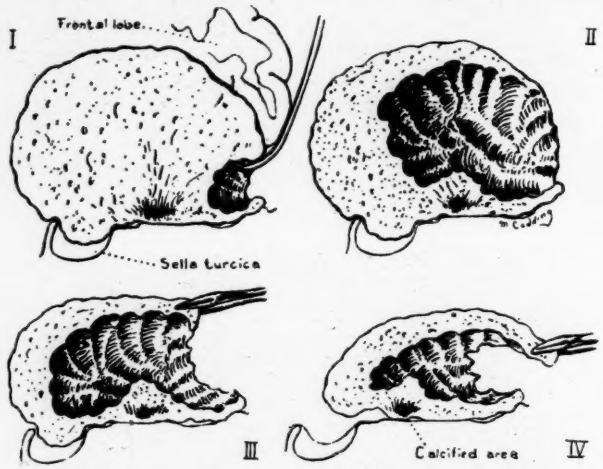

FIG. 120.—A series of drawings indicating the steps in the process of excavating a large basal tumour (in this case an olfactory groove meningioma) and of withdrawing its capsule. (*By courtesy of Dr. Cushing.*)

Attention may be drawn to two points of clinical interest. Firstly, the X-ray demonstration of the normal right optic canal, with the hyperostosis on its roof, shows, as has been pointed out by Jefferson[15] in reference to this case, that the optic nerve compression was not due to narrowing of the canal, but must have been caused by the tumour compressing the nerve in its intracranial course. Secondly, the relative nasal hemianopia in the left eye was an unusual effect for a tumour which had extended across from the right side to impinge on the medial border of the left optic nerve. The probable explanation is that the constricting agent was the opposite margin of the optic foramen, against which the nerve had been pressed, and was not the surface of the tumour itself. There is a suggestion of a similar mechanism in *Case* 5, and it was observed by Elsberg in several of the lesser wing meningiomas which he reported.

Case 5.—S. H., female, aged 35 years, was admitted to the National Hospital under Dr. Gordon Holmes on June 20, 1935, with the complaints of blindness in the right eye and headaches.

HISTORY.—Two years previously the patient discovered that the vision of the right eye was misty. She described very clearly how the visual defect progressed from above downwards,

as if a dark curtain with a straight lower border were slowly falling; this curtain took six months to reach the centre of the visual field, then she could see only in the lower periphery, and finally the eye became blind six months before admission. Three months ago she began having generalized headaches with considerable pain behind the right eye, and also occasional tinglings in the right cheek and upper lip.

FIG. 121.—*Case* 5. Radiograph, with the sphenoid ridges projected into the orbits, showing complete destruction of the lesser wing and part of the sphenoid ridge (A); the superior orbital fissure is not outlined. The right foramen rotundum (B) is enlarged.

FIG. 122.—*Case* 5. Radiograph taken obliquely through the right orbit, showing complete absence of the optic canal (normal position indicated by arrow) and destruction of the surrounding bone. Compare with *Fig.* 117.

ON EXAMINATION.—She was a healthy looking woman, with a slight proptosis of the right eye. The sense of smell was normal on both sides. The right eye was blind, with an advanced primary atrophy. The left eye had 6/6 vision, with a full field and a normal fundus. The pupils were equal in size; the right was fixed to direct light, but reacted well to consensual stimulation; the left reacted normally and both contracted well on convergence. The

ocular movements were normal. There was no detectable sensory loss or weakness of the face, arms, or legs. The deep reflexes were symmetrically hyperactive, the abdominal reflexes all equally brisk, and the plantar responses both flexor.

On lumbar puncture, the cerebrospinal fluid pressure was 250 mm. of water; the fluid contained 0·100 per cent total protein.

X-ray Examination.—Radiographic studies showed remarkable changes on the right side :—

a. In the lateral view, the right anterior clinoid was missing, and there was an erosion of the back of the orbit, which was well seen stereoscopically. The roof of the orbit was normal. There were no signs of increased intracranial pressure.

b. In the modified nose-chin position (*Fig.* 121), the lesser wing and the superior orbital fissure had disappeared. The right foramen rotundum was enlarged to 6 mm., the normal left foramen measuring 3·5 mm. in diameter.

c. The optic canal and the surrounding bone had completely disappeared (*Fig.* 122).

d. In a modified Towne's position (to show the dorsum sellæ and petrous ridges) the anterior clinoid could be well seen on the left, but was absent on the right. The right half of the dorsum sellæ was also eroded, with absence of the right posterior clinoid.

Operation was advised, but the patient refused.

On Re-admission.—The patient was re-admitted on December 3, 1935, nearly six months later. In the interval she had noticed an increase in the protrusion of the right eye and, more recently, there had been several minor uncinate attacks, consisting of a sensation of giddiness and an unpleasant smell. She had also begun to notice a transient mistiness of vision in her only seeing eye; this was the chief reason for her return. On examination, the additional signs were: a papillœdema of 3 dioptres had appeared in the left eye, but the visual field and acuity remained normal; and there was a definite increase in the proptosis of the right eye. Her general health was good.

Diagnosis.—The clinical localization of this tumour from the presence of monocular blindness, proptosis, tinglings in the distribution of the maxillary nerve, and, later, uncinate attacks, presented no difficulty. The radiographs not only confirmed this, but showed a widespread destruction of bone which was quite unexpected in the absence of involvement of the oculomotor nerves. Further X-ray studies of this bony destruction, taken from different angles, demonstrated the position of the tumour more clearly; it was on the back of the lesser wing of the sphenoid and on the floor of the middle fossa, alongside the sella turcica. There was no impairment of smell. It was decided, therefore, to approach the tumour along the floor of the middle fossa, rather than along the sphenoid ridge (with possible danger to the middle cerebral vessels). The extent of its growth upwards and backwards was unknown, but the recent onset of uncinate attacks was, for a meningioma, an ominous sign.

Operation (*Fig.* 123) by Mr. Geoffrey Jefferson.—A right fronto-temporal bone-flap was reflected. The dura was very tight; it was opened upwards until the Sylvian vessels came into view. This uncovered the temporal lobe, which immediately bulged, while the upper unopened dura continued to protect and support the Sylvian vessels. Punctures into the temporal lobe disclosed a resistance immediately beneath the surface. The tumour was uncovered by excision of a suitable area of anterior temporal cortex along a line passing upwards about 4 cm. behind the temporal pole and then forwards just below the Sylvian vessels. The interior of the tumour, which was very soft and friable, was excavated with the diathermy loop. The capsule, however, was extremely difficult to handle, for it was too soft to hold traction sutures, and was unusually adherent to the brain owing to the presence of numerous tough strands and thin-walled collateral blood-vessels, which were very short and difficult to coagulate. The desire to avoid retraction of the Sylvian vessels made it difficult to reach the upper part of the tumour. An attempt was made to mobilize the tumour by stripping the dura from the back of the great wing of the sphenoid and the floor of the middle fossa, which necessitated plugging the foramen spinosum, but even this did not succeed in displacing the mass, which was firmly attached to the inner half of the sphenoid ridge and covered the superior orbital fissure. It was estimated, however, that a large part of the tumour had been excavated, leaving only a shell adjoining the region of the sella turcica, the third ventricle, the internal carotid, and the Sylvian vessels. Owing to the danger of continuing the dissection in the neighbourhood of these structures, and the evident impossibility otherwise of complete removal, it was decided to do nothing more. The bone-flap was replaced with a

decompression. A blood transfusion was given during the later stages of the operation, at the end of which her general condition was good. She continued to improve until the following morning, when her condition became rapidly worse, and she died 36 hours later of cerebral œdema and hyperthermia.

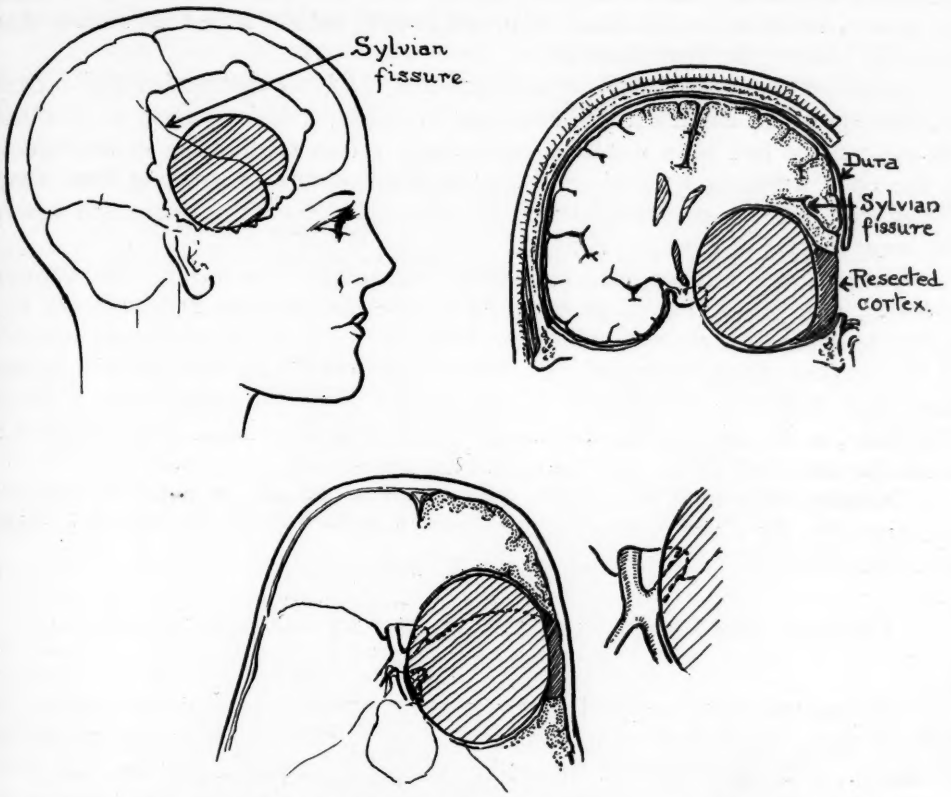

FIG. 123.—*Case* 5. Diagrams showing the resected temporal lobe (narrow shading) and the relation of the tumour (wide shading) to the right optic nerve and the right clinoid processes.

POST-MORTEM EXAMINATION.—Autopsy showed that the tumour was much larger than had been thought, and was indeed inoperable. Although a considerable quantity had been removed, it represented only a small portion of this very large growth. A rounded mass of tumour, almost as large as a tangerine, extended upwards and backwards from the sphenoid ridge. It covered the posterior part of the anterior fossa, passed inwards through the sella turcica, and also invaded the sphenoidal and ethmoidal air-cells. The right optic nerve was below the tumour. The nerves passing through the superior orbital fissure had been pushed aside and the tumour lay in contact with the trigeminal nerve.

Comment.—This case illustrates very well the stages in the clinical history of the inner sphenoid ridge tumours. The progressive loss of vision in one eye was for a long time the only symptom, and, at the time of her first admission, was the only positive sign, except for a very slight proptosis and a slight increase of intracranial pressure as revealed by the spinal fluid pressure of 250 mm.; there was no papillœdema. This was the more remarkable in view of the extensive bone destruction seen in the radiograph, but even that gave no indication of the huge size then attained by this insidious tumour. The diagnosis was clear enough, but the patient, as often happens, was not sufficiently inconvenienced by the loss of

vision in one eye to consent to operation. The raised spinal fluid pressure and the recent onset of headache, however, could be regarded as indicating the end of the period of quiescent growth. It was thus not long before more serious symptoms appeared which compelled her to return for operation, but by this time the growth had exceeded the limits of operability, if, indeed, it had not already done so at the time of her first admission.

Although the area of dural attachment and the bone destruction had become too widespread to determine the exact site of origin, it is interesting to note that the optic nerve had been displaced downwards. This relationship of the tumour to the optic nerve, and the clear history of visual failure progressing from above downwards, may be assumed to indicate that the nerve was compressed against the lower margin of the optic foramen.

Clinically, the tumour was a problem of the middle fossa alone. The autopsy, however, was instructive in showing how far these encapsulated tumours may extend upwards from the sphenoid ridge, without producing any symptoms referable to the marked displacement of the base of the brain. Further experience may show that these tumours should be approached from the front, after a frontal lobectomy, as in *Case* 4, instead of along the floor of the middle fossa, in order to avoid the restricted access due to the Sylvian vessels.

Tumours with such extensive bone destruction should probably be regarded as inoperable, for a complete tumour removal, were it possible in this case, might have been followed by infection from the sphenoidal and ethmoidal air cells.

Clinical Manifestations of the Inner Sphenoid Ridge Group of Meningiomas

The last two cases are good examples of tumours arising in this situation. In both of them, the history and the clinical signs related chiefly to the monocular blindness. They also showed interesting points of contrast. In the one, there was hyperostosis and early severe headache, while the other had bone destruction and relatively little headache. Again, one tumour was situated chiefly in the anterior fossa, with impairment of smell, and the other was chiefly in the middle fossa, with proptosis and commencing trigeminal involvement. The mesial extension of the one lay above the sella and implicated the contralateral optic nerve, while the other tumour, in the plane of the middle fossa, eroded the side of the sella and dorsum sellæ.

The notes of three earlier cases are also available. In one, the tumour was attached to the anterior clinoid, which was clearly seen in the radiograph as a greatly enlarged process; in another the anterior clinoid was completely eroded; and in the third there was a hyperostosis on the upper surface of the lesser wing, very similar to that in *Case* 4. All had the same essential syndrome of primary atrophy and approaching or actual blindness in one eye, and papillœdema in the contralateral eye. In two of them there was also a tendency to temporal hemianopia in the unaffected eye. A complete unilateral anosmia was present in two cases, but the third had no impairment of smell. None of them had proptosis or oculomotor or trigeminal nerve involvement. One case gave a history of minor uncinate attacks, and showed slight pyramidal signs. The clinical findings, therefore, indicated extension in the direction of the anterior rather than the middle fossa.

Definite X-ray changes are usually present, and are seen more constantly than with other basal meningiomas. The various changes, which often require special views for their complete demonstration, include hyperostosis at the site of origin, absence of one anterior clinoid, enlargement of the neighbouring foramina, and destruction of the surrounding bone.

The Foster Kennedy syndrome, which has come to be known as an indication of an olfactory groove meningioma extending backwards from the anterior fossa, can be very perfectly reproduced by a meningioma straddling the inner part of

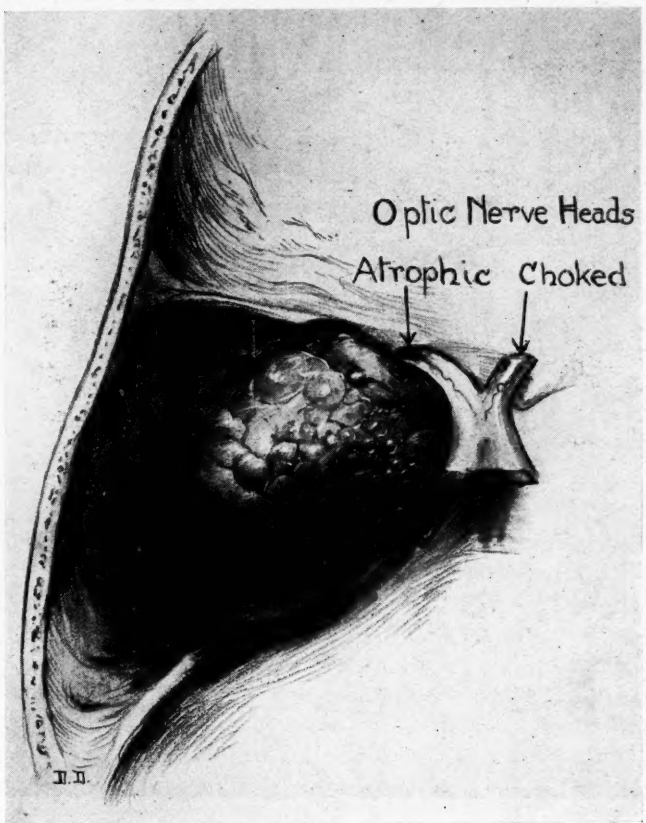

FIG. 124.—Drawing of a middle fossa meningioma to show the even greater likelihood of a Foster Kennedy syndrome with a middle fossa meningioma than with an anterior fossa meningioma. (*Lent by Mr. Jefferson.*)

the sphenoid ridge, when it is large enough to increase the intracranial pressure. It is important to recognize, from the standpoint of surgical approach, that the same syndrome may be due to a tumour which lies wholly in the middle fossa; the relationship of such a tumour to the optic nerve is shown in *Fig.* 124. The syndrome indicates, therefore, a large tumour in the neighbourhood of one optic nerve. The exact position of the tumour in relation to the anterior and middle fossæ must be determined by signs of involvement of the neighbouring cranial nerves (olfactory, oculomotor, trigeminal), by X-ray changes when present, or by ventriculography.

2. THE OUTER SPHENOID RIDGE GROUP

Morphologically, there are two types of meningioma in this region. The more common large spherical growths have a small dural attachment on the outer part of the sphenoid ridge in the neighbourhood of the pterion. They open out the Sylvian cleft, displacing the frontal lobe upwards and the temporal lobe with the Sylvian vessels backwards, and usually remain quiescent until they are large enough to increase the intracranial pressure sufficiently to produce headaches, bilateral papillœdema, and rapid failure of vision. Symptoms such as aphasia or

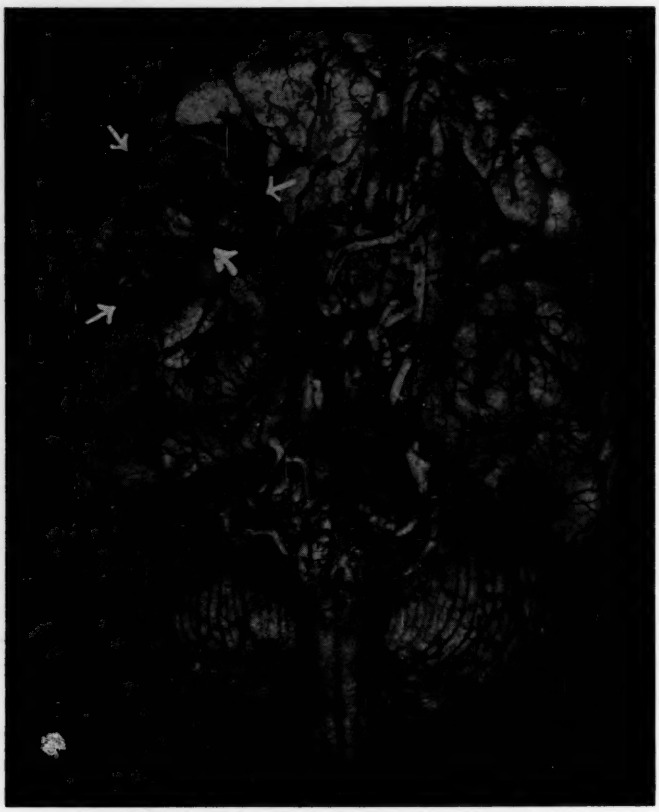

FIG. 125.—Inferior surface of the brain showing a meningioma which was attached to the dura on the outer end of the right sphenoid ridge. The patient had headaches, bilateral papillœdema, and failing vision, but no localizing signs. Compare with *Fig.* 114.

homonymous hemianopia, which commonly result from the presence of gliomas in this region of the brain, are exceptional, and in many cases blindness supervenes before the appearance of any other signs. Typical examples of tumours in this situation are shown in *Figs.* 125 and 128.

The second type of tumour, of which we have no example in this series, is the meningioma-en-plaque. The diffuse thickening of the greater wing, which also forms the lateral wall of the orbit, produces the characteristic combination of marked unilateral proptosis and an external swelling in the temporal fossa.

The essential clinical features of the large and elusive tumours at the outer end of the sphenoid ridge are illustrated by the following case report.

Case Report

Case 6.—P. D., female, aged 34 years, was admitted to the National Hospital under Dr. C. P. Symonds on July 15, 1935, with the complaints of headache and failing vision.

History.—Ten months before admission, the patient began to have increasingly severe bifrontal headaches and frequent attacks of transient loss of sight, in which she went " quite blind " for a few minutes. After a time the vision became affected permanently and then failed rapidly, until during the last month she was unable to see her way about. Vomiting occurred several times during the last three months, but was never a prominent symptom.

On Examination.—The patient, apart from approaching blindness, was a healthy, active woman with a good memory and no mental impairment or aphasia; she was right-handed. There was no abnormality apart from the ophthalmic findings. Vision was reduced

Fig. 126.—*Case* 6. Antero-posterior ventriculogram showing displacement of the ventricles to the right. At operation a meningioma was found attached to the outer end of the left sphenoid ridge.

to light perception in each eye, without any gross hemianopia, and both fundi showed a papilloedema of 2 dioptres, with advanced secondary atrophy.

Lumbar puncture revealed a cerebrospinal fluid pressure of 300 + mm. of water; the fluid contained 0·200 per cent total protein. A radiograph showed signs of increased intracranial pressure, but no localized changes to suggest the site of the tumour.

Diagnosis.—The rapid onset of blindness from high intracranial pressure without focal signs, in an adult, was very suggestive of a meningioma. No help in localization was obtained from the radiograph. It was necessary, therefore, to proceed to ventriculography (*Fig.* 126), which indicated a tumour in the left temporal region.

Operation (*Fig.* 127) by Mr. Harvey Jackson.—A left fronto-temporal flap was reflected. When the dura was opened, a meningioma was found attached to its inner surface at the outer end of the sphenoid ridge. The tumour extended into the Sylvian cleft and was almost completely hidden between the frontal and temporal lobes. It was gradually separated from the brain and removed intact, together with its small dural attachment.

The tumour was a firm, spherical mass with a slightly nodular surface. It was about the size of a golf ball and weighed 62 g. It had embedded itself in the brain along the Sylvian fissure, close to the sphenoid ridge, and had displaced the Sylvian vessels upwards and backwards.

Recovery was rapid and uneventful. The papillœdema subsided, but there was no improvement in vision, owing to the already advanced secondary atrophy. She remains in very good health.

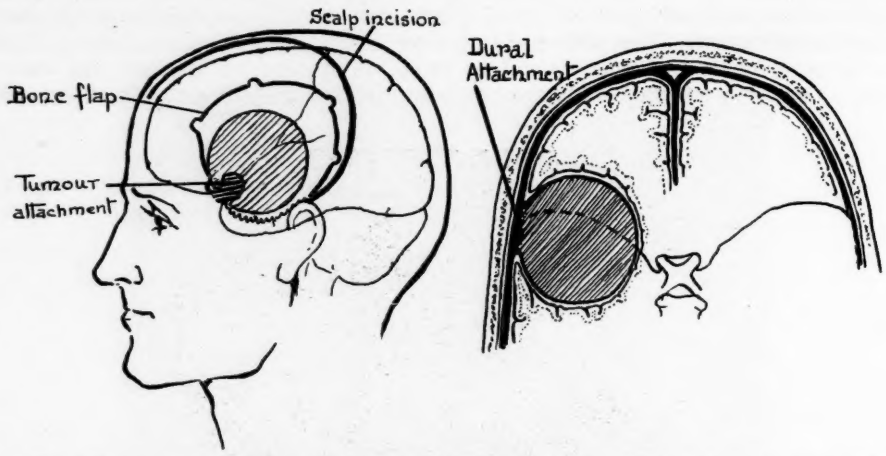

FIG. 127.—*Case* 6. Diagrams showing the dural attachment (heavily shaded) at the outer end of the sphenoid ridge. The tumour lay concealed in the Sylvian cleft.

Comment.—As not infrequently happens with these and other 'silent' meningiomas, the patient was in good health apart from the failing vision, and did not seek advice until nearly blind. Ventriculography is usually necessary for localizing these tumours if they are to be removed before blindness supervenes.

The tumour was situated at the junction of the base and the convexity of the skull, and it could be removed intact. This is the ideal method, and is frequently possible with the more accessible meningiomas in this region and over the convexity of the cerebral hemispheres. The accessibility of the area to which the tumour is attached makes this type of case generally easier to handle than those in which the tumour springs more definitely from the basal meninges.

CLINICAL MANIFESTATIONS OF THE OUTER SPHENOID RIDGE GROUP OF MENINGIOMAS

The notes of 13 cases are available. The clinical history was rarely longer than six to twelve months in duration, and consisted essentially of headaches followed within a few months by attacks of transient blindness. In the more advanced cases there was also rapid loss of vision, which in several instances had progressed to blindness. On examination, the only constant finding was bilateral papillœdema.

Marked unilateral internal strabismus and proptosis were important additional signs in 2 patients, in whom the tumour had a more extensive attachment medially as far as the middle third of the sphenoid ridge and had encroached upon the superior orbital fissure. The oculomotor nerve was never involved. Diplopia, due to slight abducens weakness, was a late effect of the high intracranial pressure in several instances.

Slight pyramidal signs (changes in the superficial and deep reflexes, weakness of the lower part of the face) were present in 8 of the 13 cases. A slight lower facial weakness, which was always on the opposite side to the tumour, was found in 7 instances; in 2 of them there were also changes in the reflexes on the same side as the facial weakness, but in 2 others the reflex changes were present on the opposite side. In another case, in which there was no facial weakness, reflex changes were found on the same side as the tumour. The occasional occurrence of early pyramidal signs on the same side as a large supratentorial tumour has been described

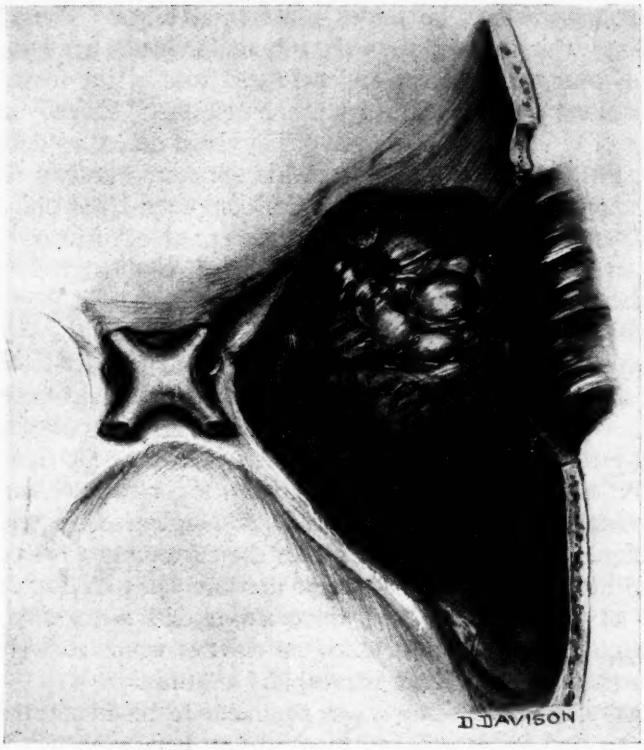

FIG. 128.—A meningioma of the outer sphenoid ridge group, without localizing signs. The patient had a five months' history of transient blindness and headaches, and examination showed only bilateral papillœdema and a left extensor plantar response. (*See* p. 158.)

by Kernohan and Woltman[16] and is well known. It is very apt to occur when the tumour has caused a marked displacement of the brain-stem to the opposite side, and is due to notching of the contralateral crus cerebri by the free edge of the tentorium. The relative escape of the facial fibres is probably due to the fact that they lie in the medial part of the crus. We regard a facial weakness, which in this series never occurred on the homolateral side, as a more reliable lateralizing sign than changes in the reflexes.

Marked tenderness was occasionally found in the temporal fossa at the outer end of the sphenoid ridge (pterion); when present it is a very valuable sign. It is important to note that none of the four cases in which the tumour was on the left side showed any aphasia, and that a slight homonymous hemianopia was detected only once. Vomiting was always a late symptom. Major or minor fits had occurred in several cases.

The radiographs frequently showed well-marked signs of increased intracranial pressure (atrophic dorsum sellæ, etc.), but localized changes were unusual. In a few cases a significant decalcification of the outer end of the sphenoid ridge may be seen when compared with the other side, by projecting the ridges into the orbits in the modified chin-nose position.

DISCUSSION

The main purpose of writing this paper has been to review the symptomatology of those meningiomas which lie under the frontal lobes. These tumours arise on one of two lines which converge on the tuberculum sellæ (*see Fig.* 104); one line extends forwards over the olfactory region to the front of the fossa, and the other extends laterally along the sphenoid ridge to the pterion. Clinically, the outstanding feature is failure of vision, and the nature of the visual defect, as determined by the perimeter and ophthalmoscope, serves to divide the cases into two clinical varieties, depending on whether or not the growth has compressed the optic nerves. The deeply situated and more inaccessible tumours produce primary optic atrophy, by which they may, fortunately, be diagnosed when comparatively small, whereas the more peripheral tumours usually remain unsuspected until they are sufficiently large to produce papillœdema.

Patients with meningiomas are usually active and healthy-looking when they first come under observation; they rarely show any obvious dementia, aphasia, paralysis, or other gross signs such as are frequently seen in patients with gliomas. Papillœdema or primary optic atrophy is in many cases the only sign of the tumour, and, if operation is delayed, vision fails rapidly and blindness commonly ensues without any striking change in the symptoms to emphasize the seriousness of the patient's condition. A meningioma displaces the surrounding structures so gradually and with so little disturbance that there are rarely any clinical signs to indicate the actual size of the growth. It is, therefore, most important to pay particular attention to the initial focal manifestations, the chief of which are visual field defects indicating compression of the optic nerves, and anosmia.

The discovery of optic atrophy or papillœdema without other neurological signs demands an immediate and full investigation which frequently must include ventriculography and even an exploratory operation. Optic atrophy is due to a variety of causes, especially tumours in the region of the optic nerves and chiasm, and such non-surgical conditions as syphilis. While tumours which cause primary optic atrophy are, in most instances, easily diagnosed by the X-ray evidence of a widely expanded sella or abnormal calcification, it is now becoming more generally recognized that blindness may result from certain removable suprasellar tumours in the complete absence of X-ray changes or other clinical signs. A chiasmal exploration is, therefore, sometimes necessary to complete the investigation of a patient with a progressive visual field defect and optic atrophy of obscure aetiology. In the same way, delay in the treatment of patients with papillœdema, which is often the only sign of a large, non-invasive, and removable tumour, in the hope that definite localizing signs will eventually appear, is not likely to be successful without jeopardizing vision. Even the former practice of making a subtemporal decompression, to preserve vision until focal signs appeared, rarely served its purpose. The introduction of ventriculography has enabled these tumours to be

diagnosed at once, with the result that many more meningiomas are now being localized and removed.

Technical advances have made operations on the more vascular and more inaccessible meningiomas much less formidable procedures, and many of the larger basal meningiomas which were formerly regarded as inoperable are now being successfully removed. The end-results, however, can be still further improved by the prompt investigation of patients with these and other benign tumours in whom the only disability is impairment of eyesight. A patient with an intracranial meningioma is fortunate in having a type of tumour which is, from the pathological standpoint, removable, but he is often less fortunate in that this may not be accomplished until vision has been very seriously damaged or even lost.

SUMMARY

1. A group of 6 patients with large anterior basal meningiomas has been utilized to illustrate the surgical problems encountered in the removal of these relatively inaccessible tumours, and the technical procedures adopted to meet these difficulties. The associated syndromes have been described by summarizing the symptomatology of other similar tumours treated at the National Hospital during the last eight years, making a total of 45 cases. The syndromes discussed are those of tumours arising from the olfactory groove, the tuberculum sellæ, and the inner or outer part of the sphenoid ridge.

2. Patients with intracranial meningiomas have two types of clinical history: (*a*) A long history of focal symptoms, or (*b*) A short history of raised intracranial pressure. This difference is determined chiefly by the position of the tumour. When the tumour is closely related to an important structure (e.g. Rolandic area, optic nerve) there is a corresponding focal sign long before other symptoms appear. The early recognition of the various syndromes makes it possible to diagnose many such tumours before the intracranial pressure is raised. Meningiomas related to the more silent areas of the brain remain quiescent until they are large enough to increase the intracranial pressure; localizing signs may never appear, so that ventriculography is often necessary for diagnosis. The duration of the clinical history in the first group may be many years; in the second group it is usually only a few months. Symptoms of damage to the cerebral hemispheres occur late and are less important than extracerebral signs (e.g., cranial nerve involvement, X-ray changes) in the diagnosis of meningiomas.

3. The olfactory groove meningiomas. The 12 cases studied fall into two well-defined clinical groups, depending on whether or not the optic nerves have been directly implicated by the tumour. What may be termed the 'anterior olfactory' syndrome of complete anosmia and recent bilateral papillœdema was present in 8 cases. With the 'posterior olfactory' syndrome there is usually a long history of monocular blindness, due to direct compression of the optic nerve, before the symptoms of increasing intracranial pressure supervene. The Foster Kennedy syndrome was present in only 2 of the 12 cases in this series, which is in marked contrast to its generally accepted frequency. Complete anosmia is the only localizing sign in the diagnosis of cases in the anterior group. Radiography may show hyperostosis at the tumour attachment, or absence of the cribriform line, both of which can be regarded as confirmatory evidence in the presence of anosmia, but

in many cases there is no definite X-ray evidence of the tumour. Reference is made to the absence of anosmia with the pre-olfactory meningiomas which lie in front of the olfactory bulb.

4. The tuberculum sellæ meningiomas implicate both optic nerves, and usually produce total blindness before they attain a large size. Thirteen examples have been summarized. They all showed the well-known syndrome of progressive bitemporal hemianopia with primary optic atrophy and a normal sella. There was no anosmia or other neighbourhood signs, and no increase of intracranial pressure. The loss of vision may be very asymmetrical; a history of bitemporal hemianopia is important in patients already blind in one eye to differentiate them from those with larger tumours at the inner end of the sphenoid ridge. The presence of positive X-ray evidence is exceptional.

5. The syndrome of meningiomas at the inner end of the sphenoid ridge is an isolated progressive failure of vision in one eye. This is followed by a long quiescent interval before other symptoms appear. These tumours may grow to a large size before causing an increase of intracranial pressure, and other localizing signs are relatively late in appearing. They lie across the sphenoid ridge and may extend chiefly into the anterior or the middle fossa. There is usually unmistakable X-ray evidence of hyperostosis or erosion, and changes in the neighbouring foramina may be seen in special views.

6. There are 13 examples of tumours arising at the outer end of the sphenoid ridge. They all showed, like meningiomas related to other relatively silent areas, the clinical picture of increased intracranial pressure of short duration, usually without any focal signs or definite localized X-ray changes. Ventriculography is generally necessary for diagnosis if the growth is to be localized and removed before permanent blindness supervenes.

7. Operation. The inaccessibility of the basal meningiomas, the large size which many of them attain before causing any great disability, and the associated high intracranial pressure, combine to make these cases much more difficult problems surgically than meningiomas of a corresponding size under the vault. The frequent excessive vascularity of the tumour, the concealed attachment, and the possibility of injury to important basal structures add to the difficulties and danger of operation. When small, they can be removed from under the brain without difficulty, and it is important to avoid delay in operation by paying special attention to the early focal symptoms when present. The fully described cases illustrate the importance of preliminary decompression, of partial resection of the frontal lobe, and of bipolar coagulation in helping towards a successful removal of the larger tumours.

Since this was written a paper has been published by David and Askenasy on the Olfactory Meningiomas (*Revue Neurologique*, 1937, lxviii, 489). My conclusions correspond with their findings that papilloedema is much more frequent, and that primary optic atrophy and the Foster Kennedy syndrome are much less common, than has generally been supposed.

I wish to acknowledge my debt of gratitude to Mr. Geoffrey Jefferson, who suggested the scope of this paper, for his encouragement and assistance; to Dr. J. G. Greenfield for helpful criticism and permission to make use of his pathological material; and to the honorary medical and surgical staff of the National Hospital for allowing me to utilize the hospital records and publish their cases.

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CRITICAL REVIEW

TUMOURS OF THE LUNG

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It is difficult to-day to realize why progress in the surgery of the chest was so delayed as compared with abdominal surgery. In fact, Reclus in an address to the French Surgical Congress in 1895 said, " the surgery of the lung does not, as Gluck said it did, follow that rule of general surgery, ' Ubi hæmorrhagia ibi ligatura, ubi tumor ibi extirpatio, ubi pus ibi incisio.' The structure of the lung and its air-passages, the part it plays in sustaining the life of the blood, its relations with the heart, and the presence of a pleural cavity, all forbid great expectations, and limit the power of the surgeon. Resection of a part of the lung for primary malignant disease is not even worth discussing."

Stephen Paget[1] somewhat ingenuously stated in 1895 : " It is sometimes said that surgeons fifty years hence will think as little of our results as we think of the methods of fifty years ago. So far as regards the surgery of the chest this is utterly untrue. Fifty years ago it had risen above the horizon. It is now nearly at its zenith."

The prophesies of surgeons appear to be as unreliable as those of other prophets.

Since the end of the Great War advance has been rapid ; improved diagnosis particularly dependent upon advances in radiological technique has been unquestionably a great factor.

The hindrance to operations upon the thoracic contents has been due to fear of the effects of open pneumothorax, and this was responsible for the various types of positive and negative pressure chambers which were devised and used during the earlier years of this century. These chambers, the positive being used for the head of the patient and the anæsthetist, and the negative for the body of the patient and all assisting at the operation, were cumbersome and expensive.

The institution of positive-pressure intratracheal anæsthesia by Auer and Meltzer was a considerable advance on the previous methods and overcame many of the apparent dangers of operation. The risk of open pneumothorax in chest operations without the use of raised intratracheal pressure is still the subject of debate. In the immediate post-war period there was considerable controversy—Sauerbruch[2] in Germany and Graham[3] in America were protagonists of the view that there were serious risks in performing extensive and prolonged operations on the thoracic contents unless positive pressure anæsthesia was used, whereas Duval[4] in France held that these dangers were much exaggerated.

The truth lies to some extent between these views, although the writer is of opinion that the views of Duval are sound and that certain of the evidence for the other side appear to have been founded upon the results of animal experiments, particularly on dogs, in whom the mediastinum will permit the passage of air and even fluid. The observations of Graham and Sauerbruch suggest that the larger the

opening in the pleura the greater the risk of death, whereas experience in the use of spinal anæsthesia for a very considerable number of thoracotomies would suggest that this is not altogether accurate. When the chest is widely opened and the lung is free from adhesions and collapsed, a patient under spinal anæsthesia, i.e., at complete rest, is able to breathe comfortably and easily. If, however, cough occurs, there is invariably some respiratory distress, which if minimal will settle in a moment or two, but if more severe can only be controlled by the administration of a little oxygen given under slight positive pressure, with a firm-fitting face-piece.

Two additional factors appear to be brought into play by the incidence of cough—the first is mediastinal movement, and the second the production of pendulum respiration. The effect of the former on the venous return to the heart is obvious; that of the latter not so clear. When respiration is quiet the collapsed lung does not appear to take any active part in the respiratory process, hence the air, during respiration, passes freely in and out of the opposite or functioning lung. As soon as irregular respiratory movements take place, the lung on the pneumothorax side expands during expiration and contracts during inspiration. Thus, the air is exchanged between the two lungs and the normal lung is receiving sub-oxygenated air with a higher CO_2 content. Respiratory rate and amplitude are increased, and thereby a vicious circle is established, which can only be broken, and the mediastinum steadied, by the administration of oxygen under slight positive pressure through a well-fitting mask for a few minutes.

The advantages of the induction of pneumothorax preliminary to operation will be considered later.

When the opening in the thoracic parieties is smaller there is a greater tendency for air to be inspired into the lung on the ' open ' side, and it is not at all uncommon during the closure of a chest to see some respiratory embarrassment when the incision is partly closed and for this to disappear when suture is complete, although there may be a medium-sized tube communicating with the pleural cavity open to the external air.

It would thus appear that, in the human, a relatively large opening into the pleura, in which the lung is free and collapsed while the patient is at complete rest, can be made with relative impunity if the remaining lung is in good condition. This is not only possible in strong young subjects, but in older patients if pneumothorax is induced before operation, i.e., the lung collapsed.

A further point of practical importance is that respiration is undisturbed if the patient lies on the operating table on the normal side, the function of which has in the past been considered to be less than that of the upper side.

Bronchospirometry, a method devised by Jacobæus and carried out by Fraenckner and Bjorkman[5] of examining the pulmonary ventilation of each lung independently, has proved that in the unopened chest the respiratory function of the lung of the lower side, with the patient in a lateral position, is greater than that of the upper side. The explanation put forward that the lower lung has a larger blood-supply as a result of gravity is not entirely convincing, but the experimental fact cannot be denied, and experience in operating upon patients with unilateral pulmonary disease supports their findings.

Another observation worthy of mention, and demonstrating the enormous respiratory reserve of the individual, is that during operations within a free pleura and with a mobile mediastinum the latter is seen to be situated well over the middle

line, and must encroach, therefore, upon the function of the presumably normal lung.

In considering the treatment of tumours of the lung, the ideal treatment being their complete eradication, it is essential to recall the anatomic relationship of the structures which are involved during such procedures, and to be cognizant of the anomalies which may be encountered.

Hovelacque, Monod, and Evrard,[6] as a result of the increased surgical procedures carried out in the thoracic cavity, have recently reviewed the anatomy of the chest and its contents, and it is largely from this source that the following description is derived.

ANATOMY OF THE LUNGS

(*Figs.* 129–132)

The Bronchi.—The main bronchi consist of an intra- and an extra-pulmonary part, the latter being much longer than is generally realized, as it is situated in part in the concavity of the hilum, termed by the authors the 'crater' of the hilum.

The bronchus divides in a monopodic and not dichotomous manner, the branches being given off from the main tube which is continued down into the lower lobe, a fact which is supported by the embryological observation that buds during development appear laterally off the main tube. These form the primary collaterals, and give rise to the bronchi of the second, third, and fourth orders.

The right main bronchus gives off two collaterals before penetrating into the inferior lobe —namely, the superior lobe bronchus and the middle lobe bronchus, which pass from the lateral and anterior walls into their respective lobes. The inferior lobe bronchus is formed by the terminal part of the main bronchus, and enters the lower lobe at the postero-inferior part of the hilum.

The left main bronchus gives off only one collateral, that to the upper lobe before penetrating the lung, which arises from the lateral wall. It is not essential to give further distribution here, but reference will be made later to certain secondary branches in so far as their anatomical distribution is necessary, but it should be recognized that it is remarkably constant.

Variation of the Lobes of the Lungs.—Normally the right lung consists of three lobes and the left lung of two lobes, but it is by no means uncommon to find lobes partially or completely fused, owing to the fissures being incomplete in extent or depth or to their absence. Total fusion is occasionally seen between the right upper and middle lobes, but is otherwise most exceptional. Supplementary fissures producing supplementary lobes are of two types, one group due to mechanical effects, i.e., a vessel isolating a segment of a lobe —the lobe of the azygos vein—the other group due to anatomical isolation of well-defined bronchial distributions. The former groups are not truly supernumerary lobes, the latter are alone such in fact.

Lucien, by a study of the disposition of the bronchial tree and of the morphological variations of the lung, has mapped out on its surface the areas supplied by the varied bronchial ramifications. He recognizes four territories—ventral, dorsal, external parabronchial, and internal parabronchial. These different primary lobar areas, which are constant, are susceptible of being independent in whole or in part. The variations are :—

1. *Supernumerary Upper Lobe.*—An *apical lobe*, either right or left, with a horizontal fissure or one oblique from below upwards and forwards. It corresponds to the distribution of the apical bronchus, and has only rarely been described.

2. *Supernumerary Middle Lobes.*—(*a*) A fissure, passing obliquely from below forwards and upwards, divides the middle lobe into upper and lower segments corresponding to the two types of ramification of the ventral bronchus. (*b*) An almost vertical fissure at the posterior part of the costal surface of the middle lobe results in the formation of an *axillary lobe.*

3. *Supernumerary Lower Lobes.*—

An *accessory posterior lobe* corresponding to the primary dorsal bronchus distribution. The posterior lobe is much more frequent on the right side than the left.

A *cardiac lobe*, corresponding to Lucien's internal parabronchial area. This lobe is normally completely isolated on the right and occasionally on the left in certain quadrupeds; its frequency in man is much debated. Deve states that it exists in 35 per cent of cases more or less complete; Lucien records 1 per cent complete separation, 7 per cent incomplete fissure, 17 per cent suggestion of fissure. Hovelacque failed to observe one case in an examination of three hundred pairs of lungs.

It forms a pyramid with the base downwards lying on the diaphragm with the apex at the hilum, and is very variable in volume. Radiologists have described this lobe as the seat of atelectasis when it shows a shadow in the radiograph.

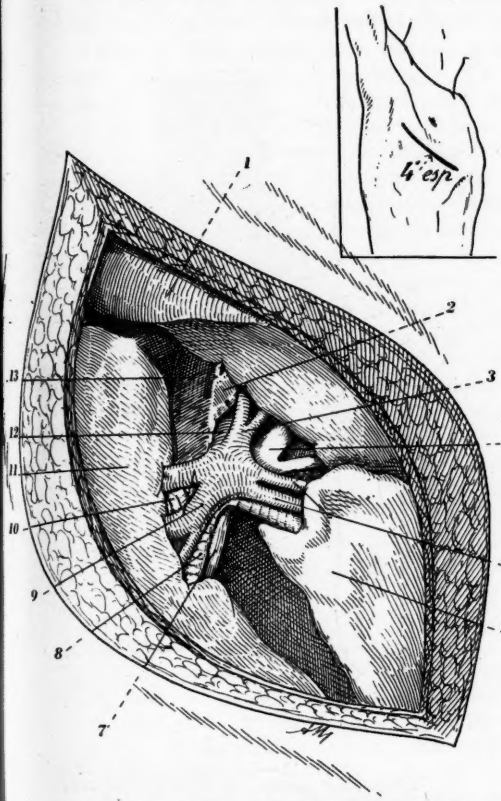

FIG. 129.—View of lobar hila of right lung. 1, Upper lobe; 2, Upper lobe bronchus; 3, Retrobronchial artery; 4, Superior pulmonary vein; 5, Middle lobar arteries; 6, Middle lobe; 7, Inferior pulmonary vein; 8, Lower lobe bronchus; 9, Lower lobar arteries; 10, Lower lobe bronchus; 11, Lower lobe; 12, Pulmonary artery after it has given off the main superior lobar branch; 13, Right main bronchus.

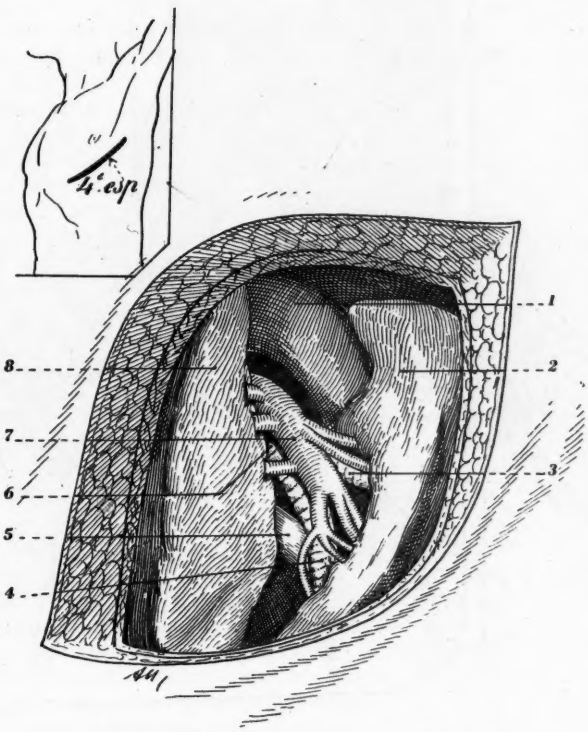

FIG. 130.—View of lobar hila of left lung. 1, Arch of aorta; 2, Lower lobe; 3 and 4, Bronchi of lower lobes; 5, Inferior pulmonary vein; 6, Lower lobe bronchus; 7, Left pulmonary artery 8, Upper lobe.

4. *Supernumerary Left Middle Lobe.*—In 1889 Ewart considered the *lingular process of the left upper lobe* as the remnant of the left middle lobe. Surgically, although no fissure may exist, it is often possible to separate this area from the remainder of the upper lobe with little bleeding, and it is suggestive that as the right middle lobe is not rarely affected with the right lower lobe in bronchiectasis, the lingular process of the left upper lobe is often involved in left lower lobe disease.

Pulmonary Arteries.—

Right Pulmonary Artery.—This passes behind the ascending arch of the aorta and superior vena cava, crosses in front of the inner border of the right main bronchus 1 cm. below the tracheal bifurcation, and gives off its main superior branch to the upper lobe. It then passes downwards, lying on the anterior surface of the main bronchus, and entering the hollow of

the lung surface it divides into two or three branches which cover the bronchus, especially on its anterior surface.

The *retrobronchial artery*, when it exists, arises from the supero-external part of the artery on the anterior surface of the main bronchus; rarely it arises from the middle or lower lobar branches. It passes behind the superior lobe bronchus and enters the lung at the upper part of the hilum behind the bronchus.

The *middle lobe arteries* arise from the main vessel, not as a single artery but as two or three collaterals. They may be situated in front or behind the corresponding bronchus.

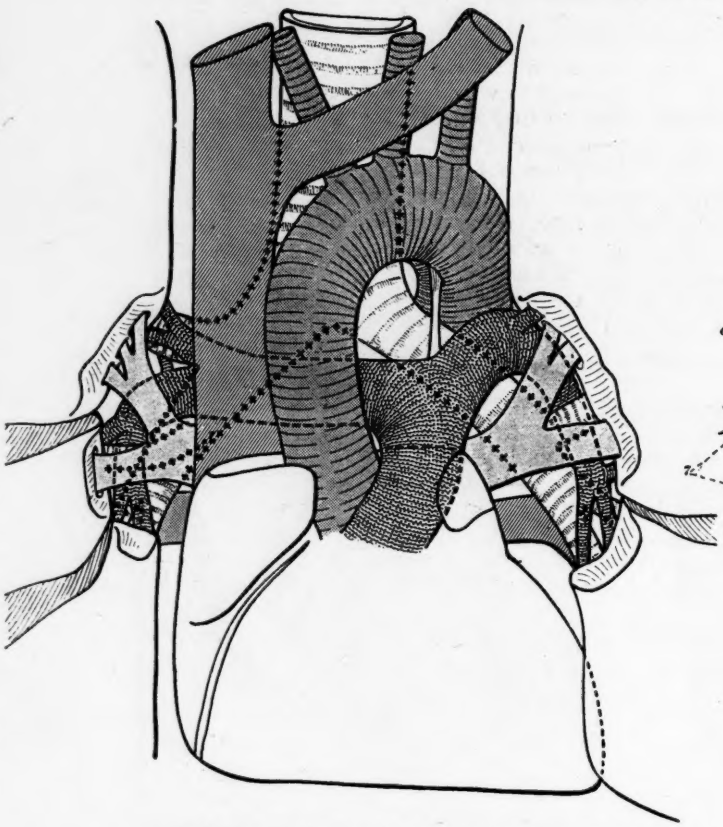

FIG. 131.—Schema to demonstrate the pulmonary pedicle and its exposure. (The anterior edge of the hilar crater is displaced outward, as is possible during operation without injury to the pulmonary tissue. The cavity of the crater is thus opened up and the pedicle exposed to direct vision.)

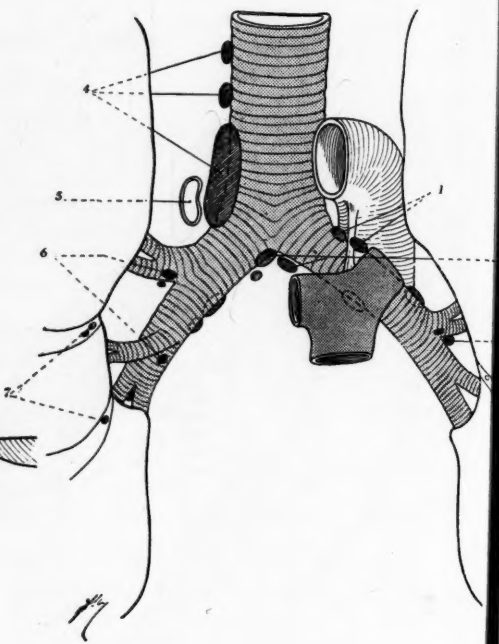

FIG. 132.—Distribution of tracheo-bronchial glands. 1, Left superior lateral tracheo-bronchial group; 2, Subcarinal group; 3 and 6, Deep hilar groups on divisions of main bronchi; 4, Right superior tracheo-bronchial group; 5, Section of vena azygos superior; 7, Fissural glands.

The *inferior lobar arteries* arise from the external surface of the main vessel, some above, but the majority below, the middle lobar vessels, and penetrate the lung near the anterior border of the hilum, often without respect to the bronchial divisions.

Variations in the right pulmonary artery: The artery, after giving off its first branch, occasionally spreads out into a fan-like group of vessels to supply the lower and middle lobes.

Left Pulmonary Artery.—This is smaller than the right artery and passes upwards, crossing the front of the left main bronchus almost perpendicularly, and then curves slightly downwards into the hilum in front of the superior lobe bronchus, and lying on the lower lobe bronchus. The termination of the artery is very variable. It may, alone or by means of several branches, penetrate the parenchyma in front of the inferior lobe bronchus, or more often may continue to keep its calibre up to its termination, where it divides up into several branches.

The superior lobar artery divides into two or three collaterals, short and broad, as it lies on the upper lobe bronchus.

Relation of Arteries to Bronchi.—At the upper part of the hilum the arteries to the superior lobe are always internal to the bronchi. In the middle area of the hilum they are placed in front and slightly outside the bronchi. At the upper part of the lower lobe area, the relationship is more variable, the arteries being usually outside the bronchi, but occasionally they are internal.

Pulmonary Veins.—The pulmonary veins take their origin as minute vessels from the perialveolar plexus and from the submucous and peribronchial plexuses. Other vessels arise in the subpleural spaces, either peripheral or in the fissures, which plexus is called the pleuro-pulmonary plexus. These radicles join together to form a plexus in the interlobar spaces, and joining other groups, form the two main veins but do not come into relationship with the artery until it approaches the hilum. The relationship between the two main veins is somewhat variable, but most frequently they are separated from one another by the bronchus.

The Right Superior Pulmonary Vein.—The vein collects blood from the upper and middle lobe, and is almost invariably placed in front of the right pulmonary artery so definitely as to preclude the possibility of ligature of the artery before division of the vein.

Left Superior Pulmonary Vein.—Drains the upper pulmonary lobe and passes to the the back of the left auricle, being the most anterior structure in its mediastinal course, although the pulmonary artery is usually not completely covered by the vein, which is slightly inferior in the hilum. Occasionally the superior branch of the vein crosses the artery perpendicularly.

Right and Left Inferior Pulmonary Veins.—These are the lowest structures in the hilum, and usually leave the lower lobes behind, and always below, the lower lobe bronchus. Both veins pass directly into the back of the left auricle.

Bronchial Arteries.—The bronchial vessels on the left side almost invariably arise from the inferior surface of the arch of the aorta, but occasionally from the lateral surface of the aorta above the origin of the fifth intercostal. They are generally two in number, arising separately or by a branch which quickly divides into two. Occasionally the right bronchial artery arises from the aorta in common with one of the left vessels, or from one of the upper intercostal arteries of the right side.

Whatsoever their origin they are usually found on the posterior surface of the main bronchi near the upper or lower border. Their secondary branches correspond to the bronchial divisions.

Lymphatics.—The final lymphatic drainage from the lungs and bronchi is into the glands around the tracheal bifurcation. These consist of a group beneath the carina and two lateral groups situated upon the upper border of the main right and left bronchi and the lateral walls of the adjacent trachea, termed the ' superior lateral tracheo-bronchial glands '. More deeply are the glands in the hilum proper, the deep sub-bronchial groups in relationship with the primary division of the main and lobar bronchi. Other lymphatic glands are found at the inner ends of the fissures and in the ligamentum latum pulmonis, a constant one being found inferior to the pulmonary end of the inferior pulmonary vein.

It is almost impossible to determine with precision the glandular area corresponding to the individual lobes of the lung—they are often imperfectly separated, and equally often the lymphatic channels from neighbouring surfaces of adjacent lobes drain into a common gland at the point of the bronchial division. This is of considerable importance in the operative treatment of carcinoma, and will be discussed later.

COMPENSATORY MECHANISMS AFTER PULMONARY RESECTION

Anatomical.—Sufficient experience has been gained from post-operative and animal experimentation to justify certain conclusions as to the way in which compensation takes place after a large resection of pulmonary tissue, as in pneumonectomy.

The first group of changes are those on the walls of the hemithorax, as a result of which certain modification may be seen within the course of a few days. The

intercostal spaces become narrowed, the diaphragm raised, the mediastinum displaced towards the affected side, the apex of the thorax falls, and scoliosis develops convex towards the operated side. Rienhoff[7] has observed two changes on the non-operated hemithorax: widening of the intercostal spaces within twenty-four hours of operation; and lowering of the diaphragm beyond the pre-operative level after a few days.

The second group comprises the changes in the remaining pulmonary tissue. In this connection there has been some difference of opinion in the past, particularly as regards the results from animal experiments. There are, of course, the possibilities of true hyperplasia of the respiratory units, of a compensatory dilatation of the same areas, and of true emphysematous changes.

Morrison,[8] following pneumonectomy in rabbits, was unable to find any evidence of true hypertrophy of the residual lung tissue, and described changes *analogous* to compensating emphysema in some areas, with an intense vascular engorgement associated with air spaces increased in size and diminished in number in others. He states that the arrangement of blood-vessels did not suggest new formation of capillaries, but rather distension and thickening of those which already existed.

Rienhoff, Reichert, and Heuer,[9] in the examination of the residual lung of dogs six months after pneumonectomy, could find no evidence of emphysema, as the elastic tissue was neither interrupted nor diminished. The predominant change was simple dilatation of the respiratory units.

Hibber,[10] using rats as experimental animals, stated that true regeneration of normal lung tissue resulting in increase in the number of respiratory lobules occurred after an interval and replaced the stage of simple alveolar distension.

Bremer[11] has shown that either of these results is possible, the determining factor being the capacity for further growth in the remaining lung in each individual case—thus, while the animal is still growing the capacity for true regeneration of the lung tissue remains, but when the animal has attained full growth, compensatory dilatation results. He points out that full-grown cats have alveoli of the same size and alveolar septa of the same thickness as kittens. Increase in the number of alveoli is accomplished by the development of terminal buds from the angles of the alveoli throughout the lung, in the form of minute tubular sprouts, which expand into new alveoli. He also points out that Hibber in using the rat as the experimental animal was led to a false conclusion, as growth in this rodent, and possibly in other rodents, continues almost through life.

Behrend and Mann[12] state with certainty, as a result of examination of the residual lung in dogs at intervals of a few days to eight years after pneumonectomy, that the enlargement of the residual lung is not due to emphysema. In their view the enlargement is likewise not due to hypertrophy of the functional unit of the lung, nor to hyperplasia. They state that organs endowed with vital functions possess a superfluity of functional units, which in times of stress, whether due to physiological or pathological causes, become available for use. The increased demand results in an increase in the number of functional units, i.e., lobules in use at one time or by simple dilatation of the terminal portion of the respiratory lobule.

Another point of interest is that these observers state that the displacement of heart and mediastinal structures to the pneumonectomized side is the result of pressure from the enlarging residual lung, and not to traction by adhesions.

This they prove by the fact that when the animal is killed and the residual lung collapses on opening the chest, the heart is found in the mid-thoracic position, although previous radiological study has demonstrated it displaced to the operated side.

The most significant microscopic changes consist of focal areas of histiocytic proliferation, producing symmetrical thickening of the alveolar walls. In the course of time an increase occurs in the capillaries intertwining among the histiocytic cells. These changes are evident six weeks after operation, but in the course of years the histiocytes acquire the characteristics of fibrocytic cells with increased capillary formation, and this is possibly an important factor in compensatory adjustment after pneumonectomy.

Further light is shed upon the anatomical changes by two patients who had been submitted to pneumonectomy by Rienhoff[13]—a woman of 68 years who died of metastases six months after operation; and a girl of $3\frac{1}{2}$ years, who died from drowning three years after operation.

In the former, the following changes were found: The remaining right upper lobe was distended and protruded into the lower cervical region, associated with elevation of the upper ribs. The mediastinal surface of the same lobe bulged towards the middle line, displacing the trachea to the left as far as the parasternal line; the postero-medial surface burrowed behind the trachea and œsophagus and in front of the vertebral column, pushing mediastinal pleura before it. This extension was interrupted below by the azygos vein and the tracheal bifurcation. The antero-medial upper lobe extended across the middle line and filled the upper anterior portion of the left thoracic cavity, the innominate artery and vein defining the upper border of the protruding portion of the right upper lobe. The middle and right lower lobes expanded through posterior and anterior mediastina—posteriorly between œsophagus in front and aorta behind. The postero-medial portion above the heart was an area incompletely filled with right lung, and contained a multilocular mass of fibrous tissue containing cyst-like spaces filled with clear, sterile fluid. The heart was rotated into the lateral portion of the left paravertebral gutter. The lung tissue exhibited compensatory dilatation of pulmonary tissue.

In the child the same gross anatomical displacements were observed, and examination of the lung tissue showed exactly similar compensatory dilatation. The alveoli, air sacs, atria, and ducti alveolaris were dilated one-third larger than the normal for age. Alveolar walls were everywhere intact and of normal thickness, and no fragillation of elastic tissue was observed, proving a condition of dilatation without true emphysema. The heart was normal in every respect, there being no cardiac hypertrophy.

The third group of changes accounts for filling of the remainder of the residual space. A fenestrated labyrinth appears to be formed from the serosanguineous fluid filling the pleural space after pneumonectomy. This coagulates and precipitates the fibrin, which forms a scaffolding in which there are pockets of varying size containing serum. Fibroblasts grow in and cause organization, with the result that the original homogeneous fibrin mass becomes transformed into a honeycomb of fibrous tissue with loculi containing fluid.

In Rienhoff's opinion compensatory adjustment by the left lung is not so good after right pneumonectomy and heart rotation not so easy, hence the increased

compensation by fibrous tissue. He is of opinion also that fibrin formation is an important factor after upper lobectomy, an opinion not shared by all other observers.

Physiological Changes.—Animal experiments have likewise been carried out to determine the effects of pneumonectomy on the physiological changes produced. Heuer and Andrus[14] have shown that for ten days after pneumonectomy a rise occurs in alveolar and blood carbon dioxide, with a corresponding fall in the oxygen content. There appears to be a gradual return to normal in about three to four weeks. There was also a 40 per cent increase in the blood-flow through the remaining lung soon after operation, with a return to normal in ten days.

Longrave, Carter, and Quill, by means of induced exercises and anoxæmic tests carried out on young healthy dogs before operation, two months later, and subsequently at monthly intervals, came to the conclusion that the cardio-respiratory reserve is sufficient for resting conditions and for moderate exercise.

The impairment of this reserve becomes more evident as extra strain is imposed, but on the other hand there is a tendency in the course of many months to show increasingly less embarrassment due to compensatory changes in the lung.

Using the anoxæmic test, the respiratory reserve is halved as a result of removal of practically 50 per cent of the functioning lung surface. However, four months later the respiratory reserve had increased to 66 per cent owing to readjustment. According to Longrave, Carter, and Quill,[15] the nature of the compensatory mechanism is not known—whether hypertrophy with or without oxygen secretion or true hyperplasia is yet to be determined.

In Rienhoff's child patient repeated examination during the three years of life after operation demonstrated that the cardio-respiratory reserve was normal.

PLEURAL AND PULMONARY REFLEX EFFECTS AT OPERATION

There can be no doubt that serious respiratory and cardio-circulatory effects can be produced by reflex action from nerve-endings in the pleura, hilum, and mediastinum. These reflexes are carried along the vagus, sympathetic, and phrenic fibres. It is well recognized that deaths have resulted from pleural reflex effects on puncture of the pleura, although it is probable that in many cases so recorded air embolism from puncture of the adherent lung is the responsible factor. The true pleural reflex can be abolished by careful local anæsthesia, although Duval states that it is often exaggerated in general anæsthesia but can be obliterated by section of the vagus nerve.

Morison demonstrated that in rabbits crushing of the pedicle by a clamp was immediately followed by the death of the animal by arrest of respiration during the inspiratory phase. This reflex was abolished by previous section of the vagus or by the introduction of novocain into the nerve at a higher level.

Nissim[16] and O'Shaughnessy[17] report hypotensive or inhibitory reflexes causing cardiac arrest by clamping or ligature *en masse* of the hilum in experimental animals.

Monod,[18] on the other hand, using dogs and monkeys for experimental observation, although noting some inhibitory effects, has shown that they were never sufficient in intensity to arrest the cardiac movement with rough handling of the hilum or even when the hilum, including the vagus nerve and its branches, is crushed.

EFFECTS OF VASCULAR LIGATION AT OPERATION

It is not so surprising to find that ligature of the lobar vessels appears to have little or no effect upon the cardiac action and blood-pressure, but when such large vessels as the main left or right pulmonary arteries are tied the result of a shunting of a considerable quantity of blood would be expected to produce definite effects. Repeated observations on patients in whom by isolated vascular ligature or tourniquet technique the vascular supply to one lung has been cut off suddenly, only rarely showed any alteration in the cardiac rate or in the blood-pressure. In these cases no attempt has been made to cut off reflex effects by the use of novocain or other local anæsthetic to the vagus or other nerves. It is obvious that other factors are responsible in cases of sudden deaths from pulmonary embolism, one of which may be the usual presence of a massive clot in both branches of the pulmonary artery. The explanation put forward by Villaret and others that there is a small localized area, either peri- or endo-vascular, from which the reflexes take their origin in sudden death from pulmonary embolism, is most doubtful. Schweigh[19] states that the pulmonary arteries represent a reflexogenic zone having comparable functions to that of the carotid sinus. The reflex appears to start from a point localized in the termination of the sensory nerves of the pulmonary arteries. Raising of the pressure in the pulmonary arteries certainly causes a reflex fall in the general blood-pressure and slowing of the heart, whereas every fall in pulmonary arterial blood-pressure gives rise to an augmented general blood-pressure and increase in the cardiac rate. Mechanical stimulation to the outer coats of the vessels produces similar effects to endovascular stimulation. In animals ligature of one of the main vessels results in slowing of the heart and the appearance of extrasystoles, a diminution of the arterial blood-pressure, and a rise in venous pressure.

During dissection of the hilum, slowing of the cardiac rate and lowering of the blood-pressure is occasionally observed, and may be sufficient to cause temporary cardiac arrest, and certainly produces more effect than the ligature of the artery.

CLOSURE OF THE BRONCHUS

Tension pneumothorax following leakage of a sutured bronchus has been the cause of death in animals following pneumonectomy, and has been the cause of fatalities in humans after lobectomy in a free pleura for bronchiectasis (Sauerbruch). This fear is largely unjustified in lobectomy by modern methods, although the late occurrence of a temporary bronchial fistula is relatively common. In pneumonectomy for carcinoma it is not rare for a fistula to develop in older patients from the eighth to the sixteenth day after operation, and although tension pneumothorax is rare, considerable risk to the patient arises from the leakage of sterile fluid in the pleura of the affected side into the opening bronchus and thence into the trachea and bronchi of the normal side. If the accident is recognized, as it should be, it can be promptly relieved by the insertion of an intercostal catheter into the pleural cavity, which will permit drainage of the fluid externally. The valvular bronchial fistula, which permits entrance of air into the pleura but which prevents its egress, must be extremely rare following either lobectomy or pneumonectomy.

Various methods have been employed to try to ensure permanent closure of the main bronchus, but none of them appear to be efficient in all cases.

Unquestionably, the main factor is the age of the patient, for in the older patients the cartilages of the main bronchi are generally hard and partially calcified, and crushing will result in rupture of the brittle cartilages through the outer wall of the bronchus. In younger subjects, the end of the bronchus may be sutured and even inverted and sewn over.

Multiple longitudinal incisions into the end of the bronchus, oblique division so as to permit the suture of the fibrous portions of the bronchial wall into the curved cartilaginous portion (Rienhoff), suture of the end of the bronchus and the use of a proximal ligature which does *not* include the bronchial artery (Thomas, Behrend, and Mann[20]), have been advocated.

There can be no doubt that the use of silk or thread rather than catgut is less likely to be followed by reopening of the sutured bronchus.

Some operators advise destruction of the mucosa of the bronchus by heat or chemical caustics.

DIAGNOSIS OF INTRAPULMONARY TUMOURS

Benign tumours are relatively rare, but the increasing use of radiological investigation of pulmonary symptoms is resulting in a great increase of patients operated upon for such conditions. There can be no doubt that many patients in the past have died from the results of pulmonary suppuration secondary to obstruction caused by intrabronchial benign growths. In other cases an extensive benign pulmonary growth may press upon the outer walls of the lobar bronchi and likewise lead to infective conditions variously diagnosed as bronchiectasis, pneumonia, or pulmonary abscess.

RARER TUMOURS OF THE LUNG

Chondromas have been described largely in autopsy records of patients dying from other conditions; and although rarely found as pedunculated tumours in the bronchi, are usually described as arising in the middle of one or other lobe. Hickey and Simpson[21] describe two personal cases, in one of which the tumour was the size of a lemon on the radiograph. They have collected a large group of cases (40), including one by Adams reported in the *Transactions of the Pathological Society of London* as early as 1850. In the discussion of their origin, the frequent subpleural situation tends to exclude the view that they originate from bronchial cartilages which have become secondarily separated. Hart considers them true neoplasms, and because of the occasional presence of connective-tissue derivatives and epithelial structures, classes them with the teratomas. Hickey and Simpson are of opinion that their genesis results from perverse development of the bronchial anlages.

That they tend to grow, and occasionally rapidly, is evidenced by a case recorded by Edling in which the tumour doubled in size within eight months, and when successfully removed had extended to the visceral pleura.

There is no case yet recorded in which a definite pre-operative diagnosis has been made—i.e., in which the radiograph has been correctly interpreted. The two main diagnostic radiological points are the nodular, lobulated periphery, and irregular calcification and ossification of the shadow.

Other tumours of a relatively non-malignant circumscribed type are the *endotheliomas*, a group of 4 of which has recently been recorded by the writer.[22]

They may be relatively symptomless in the early stages or give rise to repeated hæmoptysis. They enlarge slowly and do not metastasize as far as is known. These tumours likewise give a regular, well-circumscribed radiological shadow. In both this group and in the chondromas, the treatment advisable appears to be lobectomy, and as infection does not appear to be a factor, and especially as the endotheliomas may arise near the hilum of the lobe, it should be carried out by serial dissection of the structures of the lobar pedicle.

Other tumours such as *fibroma* and *lipoma* have been described in the lung, but in this situation they are chiefly of academic interest owing to their rarity. Tuffier[23] operated in 1889 upon an *angioma* of the lung which had eroded the ribs and formed an extension in the chest wall. The diagnosis was made before operation, the tumour exposed, and the pleura found adherent, but as considerable bleeding occurred during the dissection, a crucial incision was made and this was packed with sterile amadol soaked in ferric perchloride and a firm compressive dressing applied. The patient was well ten years later.

BRONCHIAL ADENOMA

The most common benign tumour is unquestionably the adenoma of the bronchus. They form an interesting group, and many of these in the past have been mistaken for carcinoma owing to the varied nature of their histological structure.

Commonly arising in the primary or secondary bronchi, they may be seen bronchoscopically as smooth polypoid tumours or as sessile papilloma-like masses, which probably take their origin from the mucous glands or ducts of the bronchial mucosa, although Churchill[24] considers they may be fœtal lung remnants. They are occasionally intramural, and there may be a portion outside the bronchus of greater size than the intrabronchial part. Kramer and Som[25] describe one as being as large as a grape-fruit, and state that they comprise 6 per cent of intrabronchial neoplasms (the remainder, 94 per cent, being carcinomas), and that although they have been described as occurring from the ages of 13 to 64 years, the majority are diagnosed in patients between 30 and 40 years of age. There is no positive evidence that these tumours eventually undergo malignant change, but the long history in occasional cases of bronchial carcinoma is suggestive.

Clinical signs will be absent until bronchial obstruction is partial or complete. In the former case a whistling sound may be heard especially on expiration, but when obstruction is complete, the signs of pleurisy, atelectasis, recurrent pneumonia, bronchiectasis, or lung abscess may be encountered. The early diagnosis is suggested by repeated hæmoptysis, irritative cough, or asthmatic attacks.

X-ray signs will be negative in the early stages and those of lobar or pulmonary atelectasis later. Bronchograms show either a filling defect in the lobar bronchi, or an obstruction of the bronchus either transverse or even convex upwards.

Bronchoscopic biopsy is diagnostic, but considerable pathological experience is needed to differentiate these tumours from carcinomas, and this fact accounted for a large number being classed as such even in recent years.

Treatment.—Bronchoscopic removal by punch forceps is usually undertaken, but is often associated with diathermic cauterization and radiotherapy, either deep X-ray treatment or radium. Some of these tumours are peculiarly sensitive to radium applied locally.

Kramer and Som, recording the results of treatment in 23 patients, state that 6 died, 4 of these on initial admission as the result of lung suppuration. Two died following the combination of bronchoscopic removal, diathermy, and radiotherapy—one from hæmorrhage after an illness of thirty years' duration, the other from secondary lung suppuration after an illness of thirteen years' duration. Of 17 living patients, 6 are cured and 3 are symptom-free, although 2 have a dry bronchiectasis and 1 still has partial bronchial stenosis. Five have minimal symptoms—slight cough, with or without scanty sputum. In the opinion of these authors external irradiation has no appreciable effect on the lesion.

There can be no doubt that the use of diathermy via the bronchoscope entails considerable danger of fatal secondary hæmorrhage owing to the close relationship of the larger vessels to the bronchi.

Jackson and Konzelmann,[26] in reporting 12 cases of intrabronchial adenoma, obtained improvement in all by piecemeal bronchoscopic removal of the tumours; 7 were symptomless for several years after treatment, although 1 had a dry bronchiectasis. Three had a combination of removal of the tumour with deep X-ray therapy, although in one case originally regarded as carcinoma the use of X rays before removal had not apparently influenced the growth. Rabin and Wessler[27] found in a review of their cases a tendency to recurrence after an interval—in one patient after four years. This probably resulted from incomplete removal. In two others there was presumptive evidence from the history that although originally benign, they had become malignant, one patient having a history of several years, and the other surviving for seven years before dying of carcinoma.

Summing up, the evidence suggests that piecemeal removal of the tumour through the bronchoscope, followed by the application of radium to the site of the tumour, is the best treatment.

When the tumour is large or very vascular, this may necessitate removal at several sittings. When secondary changes exist in the lobe or lung distal to the site of the tumour, and especially if infection is present, secondary removal of the lobe or lung may be required before complete relief is obtained.

CARCINOMA OF THE BRONCHUS

The large proportion of bronchial obstructions are secondary to bronchial carcinoma. The diagnosis of this disease is so frequent that it is now said to comprise 10 per cent of all carcinomas. Whether this is an exaggeration or not, this disease is sufficiently common to justify a consideration of the means at our disposal for its diagnosis at the earliest possible moment and of the method of treatment when diagnosis is verified.

In the present state of our knowledge of the aetiology of carcinoma and of the benefits to be expected from radiotherapy, it is generally accepted that a malignant focus should be widely excised *en masse* with its immediate lymphatics—channels and glands. The treatment of carcinoma of the lung should prove no exception to this universal rule, and it is only when this is impossible that consideration should be given to alternative methods of treatment.

Unfortunately, the onset of malignant changes in a bronchus is usually insidious, and although in many instances a history of slight deterioration in health may be obtainable, it may not be until partial or complete obstruction to the bronchial

lumen is evident that the lung is recognized as the site of the lesion. For this reason, it is probable that the proportion of operable cases to those diagnosed will always be relatively small, but as the value of diagnostic measures become better recognized this proportion will certainly rise.

PATHOLOGY

There are certain features about the pathological histology of carcinomas in the lung which have led to considerable confusion in the past. The so-called 'oat-celled' carcinoma was until comparatively recently thought to be a sarcoma, and this fact accounts for the relative frequency of reports of sarcoma of the lung in the older literature.

Another factor is the pleomorphic appearance of many pulmonary cancers, the same tumour often containing differing types of malignant cells. The third point is the occurrence of squamous-celled carcinoma in the bronchi which are normally lined by cuboidal or low columnar ciliated epithelium, and this was thought to be due to metaplasia of the lining cells, possibly as the result of long-continued infection, by which they were replaced by squamous cells in which the malignant change occurred.

Lastly, considerable doubt has been thrown on the view that the more peripheral carcinomas arise in the lining cells of the alveoli—alveolar carcinoma.

Fried[28] has enunciated the view that all carcinomas in the lung are bronchial in origin, and take their origin in the basement cells of the bronchial mucosa. These cells are undifferentiated, and when carcinoma arises in them, they may develop into squamous-cell carcinoma, adenocarcinoma, oat-cell, or undifferentiated carcinoma, and this hypothesis offers an explanation why even different parts of the same malignant mass may contain cells of different malignant type.

He considers the lining cells of the alveoli as mesoblastic in origin, and is of opinion that the peripheral types of carcinoma arise in the bronchioles and small bronchi. There has been wide acceptance of this view, and other pathologists have confirmed Fried's work.

Tuttle and Womack[29] have attempted grading of the tumours according to their malignancy, but recognize that owing to their pleomorphic nature there is considerable difficulty. However, in grading their tumours into three groups they show that in some measure the prognosis can be predetermined. Thus in *Group I* cases the average length of life after onset of symptoms was 22.6 months; in *Group II*, 16 months, and in *Group III*, 8 to 12 months. Another point in their investigation is that in the peripheral growths, i.e., those arising in the minor bronchi, only 20 per cent of carcinomas were graded *Group I*, whereas in those arising in main bronchi or the beginning of secondary bronchi, *Group I* predominate to the extent of almost 50 per cent. Thus it would appear that the more peripheral growths should be associated with a more grave prognosis than the more central ones. From an analysis of their cases it was found that those patients in whom the growth could be visualized bronchoscopically lived an average of 33.9 months, while those not so visualized lived for an average of only 13.7 months.

Tuttle and Womack suggest that there are probably several other factors responsible—increased motion of the lung, greater vascularity with thin-walled blood-vessels, and perhaps the cartilaginous barrier of the larger bronchi, to account for the poorer prognosis in peripheral growths.

Rabin and Neuhof,[30] in a study of 250 cases of primary lung cancers, in which 100 autopsies were carried out, adopt a clinical classification using only gross topographical features as to probable operability. They are divided into circumscribed and diffuse groups, of which the former comprise 25 per cent of the cases. In their experience the circumscribed tumours occupy the parenchymal and peripheral zones of the lung, and in these regional glandular involvement is late. The diffuse type comprise tumours growing from main and from branch bronchi, and show relatively early invasion.

The peripheral and parenchymal tumours tend to fall into the class of operability. The majority of main and branch bronchus tumours do not fall into the operable class.

The history of 5 patients submitted to lobectomy would in some way appear to confirm the views of Tuttle and Womack as to the earlier invasion of the bloodstream in the peripheral groups, as 4 died with metastases in under fifteen months, and the other three days after operation without evidence of metastasis.

DIAGNOSIS

It is not proposed to consider methods of diagnosis here which are well accepted; but as in carcinoma elsewhere, a definite deviation from the normal in the patient's clinical history is of definite significance, especially after forty years of age.

In bronchial carcinoma it is quite common to get a history of some deterioration in general health, occasionally for several months, before symptoms suggestive of pulmonary disease manifest themselves. In some of these cases a radiological diagnosis has been arrived at because a film exposed for upper abdominal examination has included the lower half of the lung fields and, thereby, demonstrated some pulmonary abnormality. The reference of pulmonary symptoms to the upper abdomen is well recognized. In other cases, persistent non-productive cough, minor degrees of hæmoptysis, slight but persistent dyspnœa, are all suggestive symptoms.

In others, symptoms due to secondary deposits may be the first indication of bronchial carcinoma. They may be those of cerebral tumour, mediastinal obstruction, spontaneous fracture of a rib, or pleural effusion.

Special Investigations.—

Sputum Examination.—Certain special investigations have resulted in improvement in diagnosis, and of these the examination of the sputum for malignant cells is of considerable importance. Very occasionally macroscopic fragments of growth have been found in the sputum, but so rarely as to be of no diagnostic importance. More recently, Dudgeon[31] has published the 'wet-film' method of examination of the sputum for malignant cells, which gives a positive finding in 60 per cent of cases subsequently confirmed—a much higher proportion than any method other than bronchoscopic biopsy. (*Fig.* 133.)

As about 20 per cent of carcinomas are not visible to the bronchoscope owing to their more peripheral origin, it suggests that these two methods combined should give a positive result in about 90 per cent of bronchial carcinomas.

Bronchoscopic Examination.—The situation of 75 to 80 per cent of bronchial carcinomas in the main lobar bronchi or at the commencement of the secondary

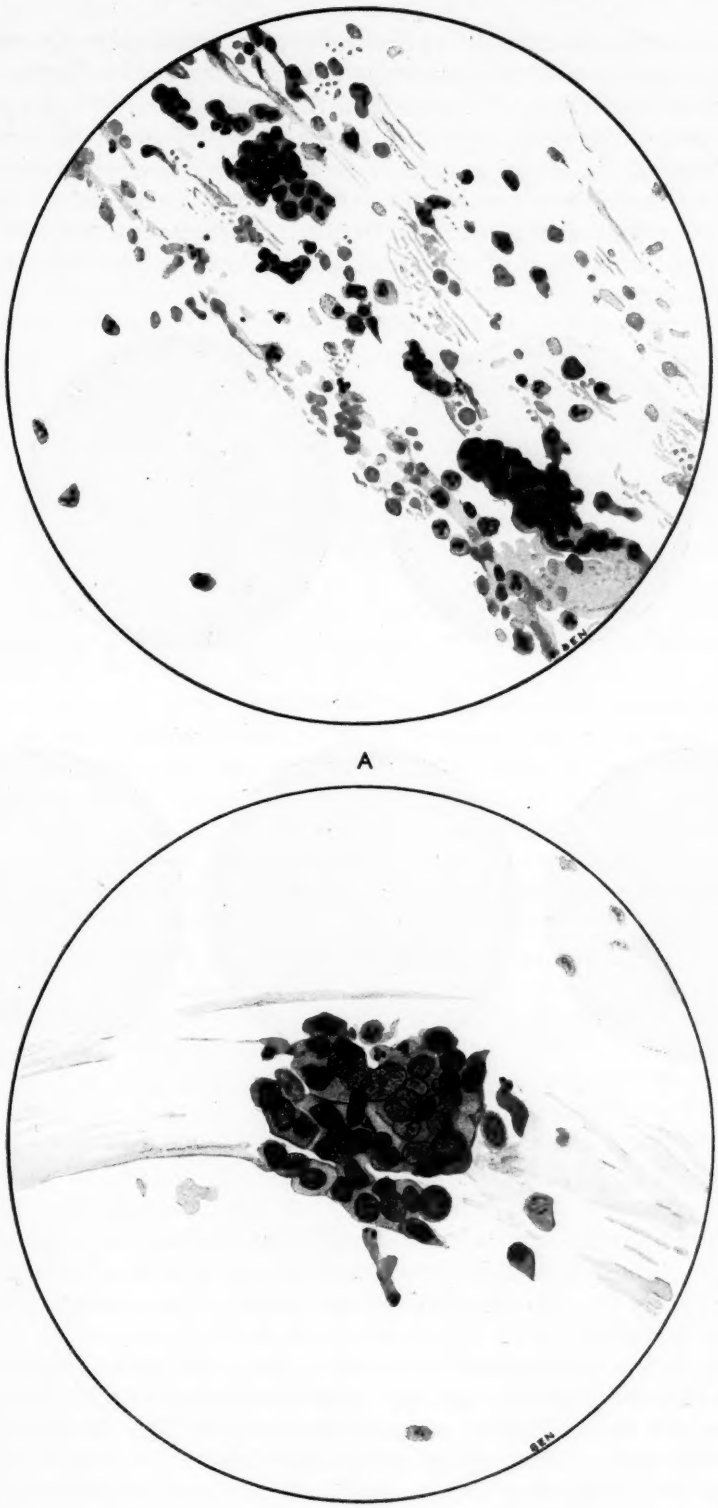

FIG. 133.—Smears of sputum prepared and stained by Dudgeon's method. A. Oat-celled carcinoma; B, Squamous-celled carcinoma. (× 300.) (*Prepared by F. S. Gowar.*)

bronchi, all of which are visible by bronchoscopic examination, is sufficient to emphasize the importance of this examination in diagnosis, particularly in association with histological examination of a portion of the growth removed. Its importance is not solely that of diagnosis, as it may give some indication of the possibility or otherwise of radical operative measures. Any broadening of the carina between the two main bronchi is suggestive of glandular involvement below the tracheal bifurcation, and would contra-indicate operation. Furthermore, the exact situation of the growth and the rigidity of the bronchial walls in its neighbourhood are points of considerable surgical interest (*Fig.* 134).

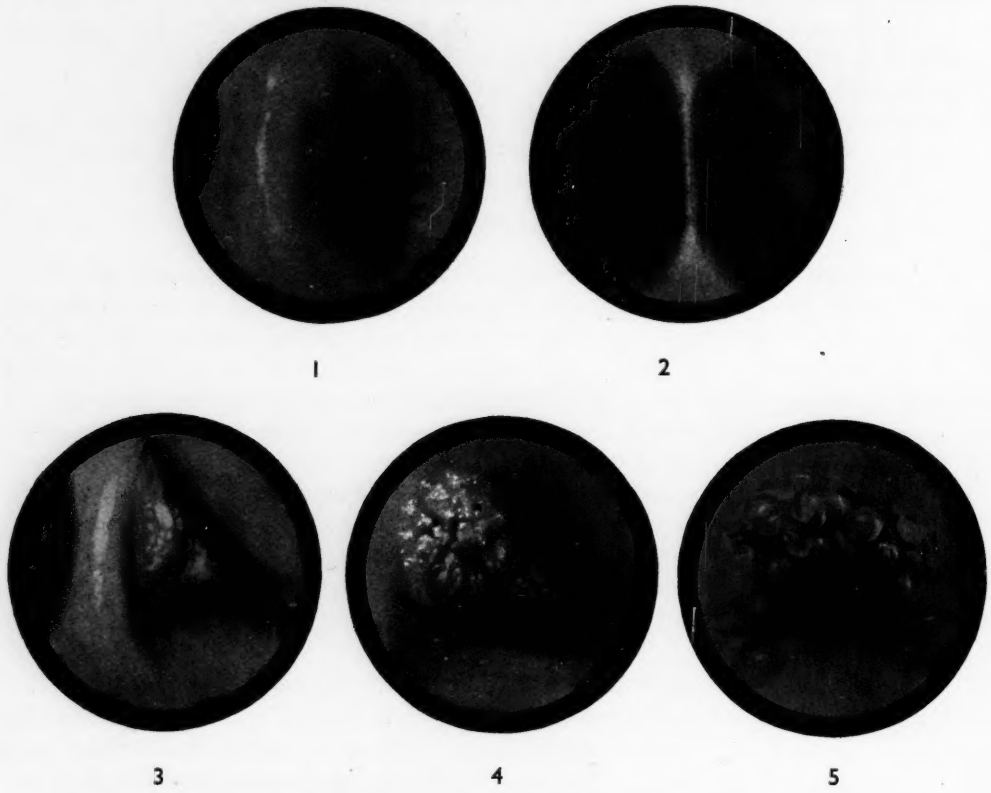

FIG. 134.—Bronchoscopic examination. 1, Submucous infiltrating carcinoma obstructing bronchus of left lower lobe; 2, Main carina (normal); 3, Proliferating carcinoma of right main bronchus extending to main carina; 4 and 5, Two 'close-up' views of same.

Jackson and Konzelmann[32] obtained positive results in 75 per cent of bronchial carcinomas by bronchoscopic biopsy, while Kramer and Som[33] obtained positive results in 152 out of 200 clinically proved cases of carcinoma. In 48 cases a biopsy was unobtainable.

Radiology.—It is not proposed to consider the radiological appearances with or without the use of opaque oil, although they are of very considerable importance, as they have been very widely discussed in all articles on this disease, but the value of the more modern method of *tomography* is still *sub judice*. It can be said, however, that there is every indication that this method will be of considerable value, and it has already been possible to show the outline of growths in the main bronchi;

and in the more peripheral neoplasms which have broken down and simulated pulmonary abscess, the gross thickness of the cavity wall due to the presence of neoplastic tissue is demonstrable.

Pleural Effusions.—Associated pleural effusions may be clear or sanguineous. In some cases the effusion is associated with the presence of secondary malignant deposits in the pleura, and malignant cells may be demonstrated on examination of the sediment by Dudgeon's method or the centrifugalized deposit may be hardened in formalin and then prepared for microscopic examination as for solid tissues (Mandelbaum's method). In other cases, the effusion appears to result from obstruction of the lymphatic drainage in the mediastinum due to the presence of secondary deposits in lymphatic glands, and in this type no malignant cells are demonstrable in the pleural exudate. In both cases, however, the presence of a pleural effusion appears to be a contra-indication to radical operation.

TREATMENT

The Question of Operability.—Every patient in whom a diagnosis of bronchial carcinoma has been made should be submitted to exploratory thoracotomy unless there are definite contra-indications.

What are the contra-indications? They may be divided up into the general contra-indications for any major surgical measure and to those associated with the disease itself.

It does not need any emphasis to state that a patient whose cardiovascular system is not reasonably satisfactory for his particular age is unlikely to withstand a major chest operation. Any recent history of even minor degrees of cardiac failure should be viewed with considerable suspicion.

Likewise, any but a minor degree of emphysema is a barrier to a successful convalescence, even when the operation is safely passed. The estimation of the vital capacity before and after induction of pneumothorax offers valuable information on this point.

Renal disease, diabetes, even when controlled, and other systemic conditions are also general contra-indications.

The contra-indications due to the disease itself are essentially those due to secondary deposits. Careful investigation of the central nervous system, the abdomen, and the areas of glandular drainage, neck and axillæ, should be carried out. The presence of pleural effusion or of carinal broadening on bronchoscopic examination are other indications of inoperability.

When the criteria of operability are satisfied, exploratory thoracotomy, with a view to radical operation, is indicated, but even then it is unlikely that of these more than 60 per cent will be found operable. In the writer's series 20 thoracotomies have been carried out on patients who appeared to satisfy the criteria of operability, and dissection pneumonectomy was possible in 13 of these.

Type of Operation.—A study of the anatomy of the lymphatic drainage of the lung indicates that there is considerable intercommunication of the lymphatic radicles between the lobes of the lung, especially as the hilum is reached. In addition, partial fusion of lobes is relatively common. Furthermore, if operative procedures for bronchial carcinoma are to meet with the success of similar operations in other parts of the body, it is essential that the main mass of lymphatic glands into which drainage occurs should be removed with the growth itself.

For these reasons, limited operations such as lobectomy are unlikely to meet with any considerable measure of permanent success, and it is essential to remove the whole lung with its lymphatics and glands.

The next point is the method of removal that should be employed. Where a lung is excised for bronchiectasis or infected cystic disease involving the whole organ, it is not essential that the amputation should be carried out high in the main bronchus, as the result is equally satisfactory if the division takes place at the commencement of the lobar bronchi. Bonniot, Monod, and Evrard[34] have demonstrated in experiments on the cadaver that it is impossible to apply a tourniquet sufficiently high up in the pedicle to be able to divide the main bronchus without serious risk to the pericardium or mediastinal structures such as the œsophagus. When the tourniquet was safely applied, section immediately distal to it invariably passed through the lobar bronchi. Thus the tourniquet method would only be satisfactory for growths which are more peripheral (20 to 25 per cent), and would exclude the greater proportion from the possibility of operation.

Thus two factors are apparent: that bronchial carcinoma should be treated, where operable, by pneumonectomy; and that the procedure should consist of serial ligature of the pulmonary artery and the two pulmonary veins, and deliberate division of the main bronchus as high as possible, i.e., not more than half an inch below the tracheal bifurcation.

Sufficient experience has now been gained to show that the operation is not only advisable but practicable, and groups of cases have been published by Rienhoff and by Overholt,[35] while other cases, as yet unpublished, have been carried out successfully by thoracic surgeons in this country by the method of dissection pneumonectomy.

Anæsthesia.—The great majority of pneumonectomies have been performed under general anæsthesia, using either positive pharyngeal or intratracheal pressure, associated or not with basal narcosis.

Of general anæsthetics nitrous oxide and cyclopropane appear to be the anæsthetics in most general use, the latter having the considerable advantage that its administration is associated with 80 per cent of oxygen—a considerable gain where anoxæmia may be a factor.

Some anæsthetists make routine use of avertin as the basal narcotic, while others prefer an easy induction by the use of limited doses of evipan, pentothal, or nembutal.

In this country, a considerable number of lobectomies and pneumonectomies have been carried out under spinal anæsthesia with most satisfactory results. Percaine (1–1500) has been generally employed owing to its more prolonged effect, and by means of posture it has been found possible to produce a consistent anæsthesia up to the level of the 3rd dorsal segment, which is maintained for well over two hours. (It is probable that this level is attained in the majority of patients in whom this anæsthetic is used for upper abdominal operations.)

The advantages of cutting off nerve impulses arising from separation of dense adhesions between lung and chest wall, and thereby limiting shock, are obvious, and although it is common to see a preliminary fall in blood-pressure, this is rarely considerable, is controllable, and there is a tendency for the blood-pressure fall due to the anæsthetic to rise during the later stages of the operation, when the operative effects should be appearing. Spinal anæsthesia can be accompanied by the

administration of oxygen through a face-piece where this appears desirable, and by means of basal narcotics the disadvantage of a conscious patient can be overcome.

Attempts have been made recently to obtain unilateral spinal anæsthesia, but this method is still on trial (Harris and Rink[36]).

Preliminary Pneumothorax.—The induction of pre-operative pneumothorax has several advantages. Where this is attempted and found to be impossible, the presence of generalized adhesions is indicated, but it is often possible to obtain some idea of the density of the pleura by its resistance to the needle. In other cases pneumothorax can be established and it is found on further radiological examination that adhesions are confined to the area of the obstructed atelectatic lobe and the relatively normal area of lung has been compressed, while in a few cases complete pulmonary collapse is possible. Thus a definite conclusion can be arrived at about the distribution and, to some extent, the nature of the pleural adhesions.

The second advantage is that it affords a means of determining the functional capacity of the remaining lung—a point of considerable importance in older patients—and this can be further and more accurately estimated by calculation of the vital capacity before and after establishment of the pneumothorax.

Again, the collapse of the lung shunts the blood-supply of the affected lung, and thus diminishes the sudden vascular change which takes place when the pulmonary vessels are ligated at operation.

Both the cutting off of the respiratory function and the vascular supply are thus more gradually brought about, and the patient permitted a relative adjustment before operation.

Lastly, there can be no doubt that when pneumothorax is induced before operation there is less operative upset when the pleura is opened, and although this is important in all thoracotomies, it is especially so in older subjects who comprise the larger number of carcinoma patients.

It is advisable to induce pneumothorax at least two, and preferably three or four, weeks before pneumonectomy for bronchial carcinoma.

Other Pre-operative Preparation.—As for all major operative procedures, a careful assessment of the condition of the cardiovascular system is carried out. This includes determination of the blood-pressure, full blood-counts, complete urinalysis, and, when indicated, electrocardiographic examination.

In every case it is essential to be prepared for a blood transfusion by grouping of the patient and cross-grouping with the prospective donor. It is wise to draw off the blood from the donor as soon as the chest has been opened and it is decided that the condition is operable.

Rienhoff has advised the production of sero-fibrinous pleurisy before pneumonectomy. The advantage claimed for this procedure is that the pleurisy is associated with the formation of granulation tissue which is more difficult to infect, and a defence mechanism is mobilized which provides for the phagocytosis of bacteria which may contaminate the field. After the induction of pneumothorax he injects 50 c.c. of beef broth bouillon of the bacteriological laboratory (used for cultural purposes with 1 per cent peptone solution) into the pleural cavity, and by rotation of the patient the solution is allowed to come into contact with all pleural surfaces. This produces a reaction, with temporary pain, pyrexia, and increased respiration and pulse-rate. The effusion reaches its maximum in from 24 to 48 hours, with polymorphs predominating. Up to the fifth day the polymorphs

diminish as the lymphocytes increase. The result Rienhoff terms a " sterile abscess cavity." This procedure may have advantages where complete collapse of the lung is attainable, i.e., where there is complete absence of adhesions, but general experience is that such cases are relatively rare.

Pneumonectomy.—Two lines of approach may be employed, the antero-lateral and the postero-lateral, and each has advocates. Overholt[37] appears to favour the postero-lateral approach when difficulties in mobilization of the lung are anticipated, whereas Rienhoff[38] favours the antero-lateral. There can be little doubt that in cases of bronchiectasis in which complete pneumonectomy is required, and where serial hilar dissection is unnecessary, the postero-lateral approach is entirely satisfactory. In carcinoma it is essential to have an adequate exposure of the front of the hilum. The majority of patients with bronchial carcinoma have some bronchial obstruction, and therefore partial or complete atelectasis of a lobe is comparatively common. As low-grade infection in the collapsed lobe is almost invariably associated with pleural adhesions, and these may be dense and firm, often more so than in cases of bronchiectasis, it is essential that an adequate approach should be obtained for their division. In the reviewer's experience it appears advisable, therefore, to employ the antero-lateral incision when the neoplasm affects the upper lobe bronchus, as it gives a better approach to the apex, where the adhesions are more likely to be dense, and to employ the postero-lateral approach in cases of carcinoma of a lower lobe bronchus, thus giving a better approach to the lower chest and diaphragm. In the lower lobe carcinomas, the upper lobe is generally compressible and can be held downwards and backwards, permitting approach to the front of the hilum for dissection.

Rienhoff has proposed and carried out a two-stage operation, the first stage being terminated after ligature of the pulmonary artery, the veins and bronchus being dealt with at a second operation. The bronchial artery supply is sufficient to prevent gangrene of the lung. Although technically possible on the left side, it must prove more difficult on the right side, where the artery is so covered by the superior pulmonary vein that it can rarely be exposed until the vein has been ligatured and divided.

As soon as the patient is in position upon the table, a vein in the lower part of the leg is opened, a cannula connected to a drip-saline apparatus introduced, and the whole firmly secured by strapping. A very slow saline infusion is started, and when the pulmonary condition has been found operable, blood is withdrawn from the donor. During the operation the blood is introduced into the saline apparatus and its speed of entry controlled by the condition of the patient and an estimate of the blood-loss. Thus a slow drip-blood transfusion is given without adding to the risk of overloading the right heart—an important consideration where one pulmonary artery is to be, or has been, ligatured, a procedure which must necessarily increase the pressure in the right ventricle. The blood-pressure and pulse are recorded at five-minute intervals.

The Incision.—In the antero-lateral exposure two incisions may be used: One transversely from just external to the middle line outwards over the third intercostal space (Rienhoff); this incision is deepened through the third interspace and the cartilages of the 3rd and 4th ribs are divided. The other, which gives a wider exposure, is a curved incision below the breast and upwards parallel to the sternum (*Fig.* 135). The fifth interspace from the axilla to the parasternal line is entered, and

the cartilages of the 5th, 4th, 3rd, and possibly the 2nd, ribs divided anteriorly. A large flap is thus turned up, giving a wide exposure of the chest contents (*Figs.* 136, 137). This is an excellent incision not only for anterior exposure of the

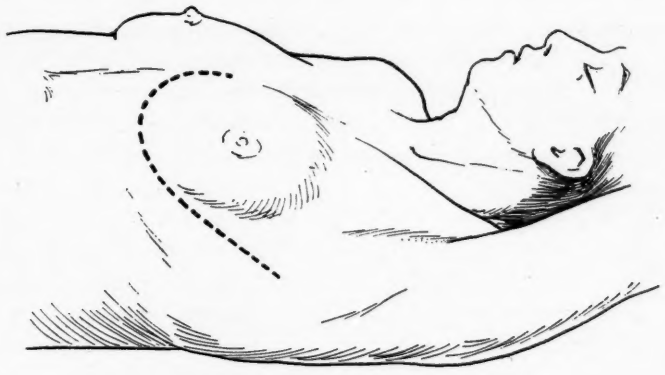

FIG. 135.—Showing curved antero-lateral incision.

hilum but for all anterior mediastinal tumours, and has been used for such by the writer for many years. The postero-lateral incision is made by superficial incision over the 7th interspace posteriorly, and is carried forward to the nipple line (*Fig.* 138). The interspace is opened and widened by division, with removal of small segments of the 8th, 7th, 6th, and 5th ribs (*Fig.* 139).

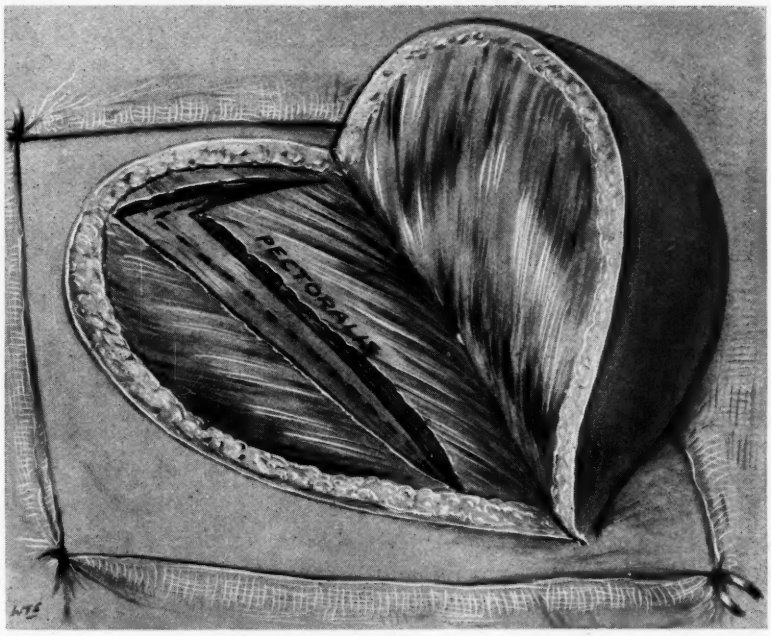

FIG. 136.—Showing the flap raised.

In every case, after careful palpation of the hilum and mediastinum for hard, enlarged glands, all adhesions are separated and the lung mobilized before

attempting the hilar dissection. Enlarged soft glands are nearly always palpable in the hilum, and are due to the superimposed infection in the obstructed portion of the lung, and do not contra-indicate operation.

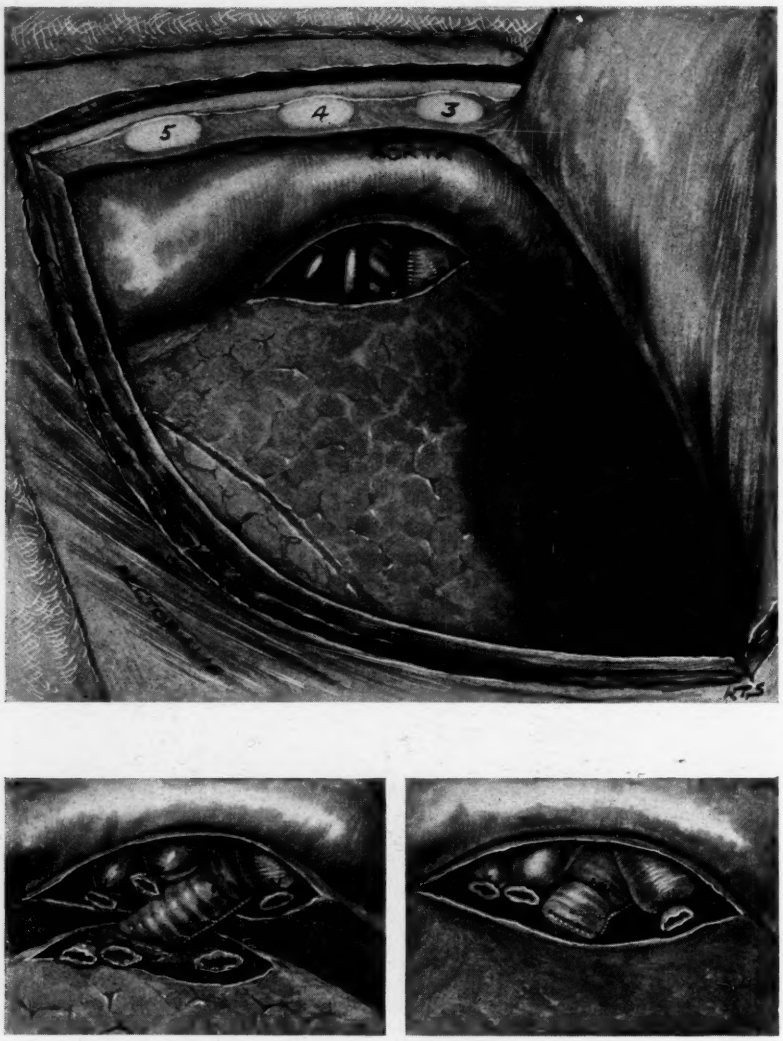

FIG. 137.—Exposure of the lung and hilar region.

Ligature of the main vessels requires the use of thread or silk, as catgut is inclined to slip, and it is advisable to tie two ligatures upon the proximal point and one at the distal end to ensure safety.

Archibald has stated that it is not possible to perform a dissection pneumonectomy on the right side, but this has subsequently been disproved, although it is occasionally impossible to apply proximal and distal ligatures and to have sufficient room to enable the vessel to be divided safely between (*Fig.* 140). In such cases arterial forceps are applied to the distal ends and the vessel divided against the

forceps. The use of vascular clips of sufficient size might facilitate the later dissection in such cases, as the forceps are inclined to obstruct the operative field.

After ligation of the pulmonary artery and the two pulmonary veins, division

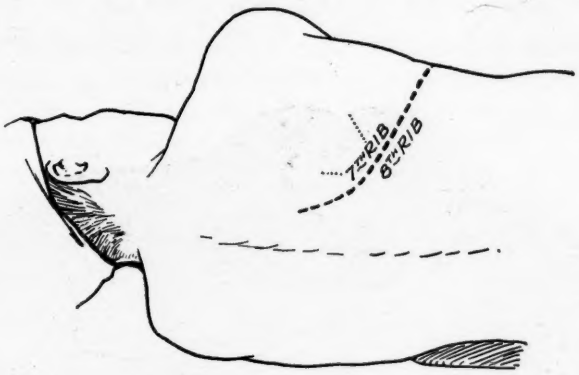

FIG. 138.—The postero-lateral incision.

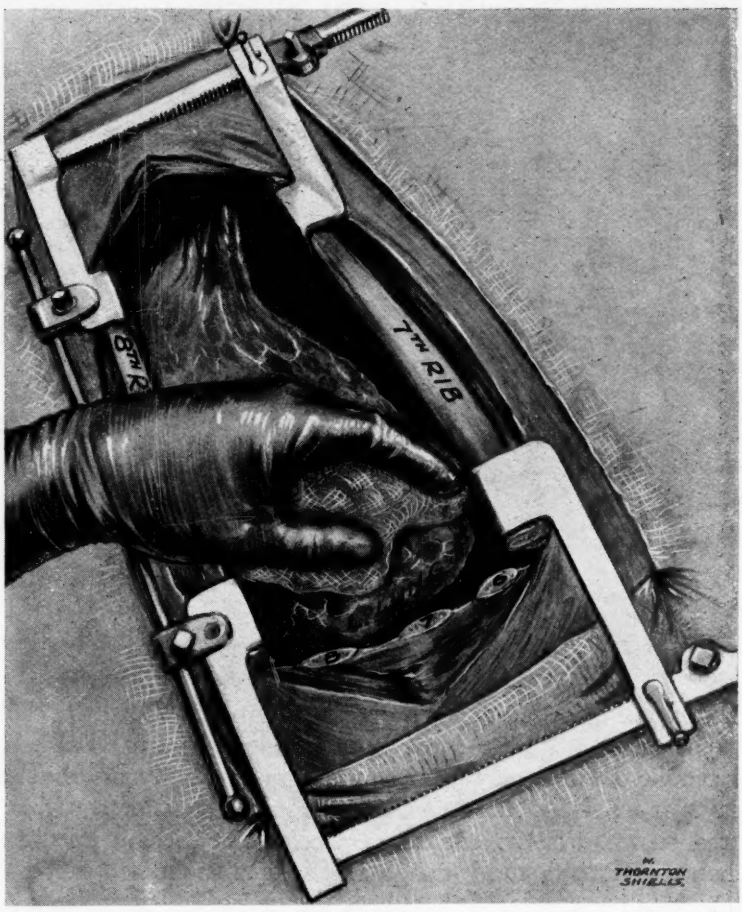

FIG. 139.—The extent of exposure obtained by the postero-lateral approach.

is made of the pleura over the back of the hilum and of minor mediastino-pulmonary adhesions; the lung can then be swung outwards on its bronchial pedicle.

The methods of bronchial closure have been referred to earlier, but in younger subjects it is possible to divide the bronchus, suture the end, invert it, and then oversew with another layer of sutures. In older subjects the bronchus is divided

FIG. 140.—Right lung, the site of bronchial carcinoma, successfully removed by dissection pneumonectomy.

between clamps and ligatured about a quarter of an inch above the clamp, but the ligature should be placed around the bronchus so as *not to include the bronchial vessels* and should be tied only sufficiently tightly to occlude the lumen. The terminal clamp is removed, and the end of the bronchus sutured with a continuous silk or thread suture. This method was successfully used in pneumonectomy in dogs by Thomas, Behrend, and Mann, and is a valuable method as it can be carried out relatively rapidly—an essential towards the end of an extensive and prolonged operation. It has been employed by the writer in two cases with permanent closure

of the bronchus. The stump of the bronchus retracts into the mediastinum and the divided edges of the mediastinal pleura are sutured.

The question of pleural drainage after pneumonectomy for carcinoma of the lung is still debatable. Some thoracic surgeons suture the chest without drainage, but it is probable that adjustment occurs more easily if an intercostal tube is introduced into the pleural cavity between the 8th and 9th ribs posteriorly and *removed after twenty-four hours*. Any excessive bleeding from severed adhesions can be determined and the mediastinum is permitted to adjust itself.

After-treatment.—Most surgeons place their patients after pneumonectomy in an oxygen tent in a semi-sitting posture, inclined to the side of operation. Rienhoff, on the other hand, uses the Trendelenburg position for twenty-four hours, and claims that it permits free bronchial and tracheal drainage with minimum effort to the patient. In addition, the elevation of the bed and the position of the patient is changed from side to side every two hours day and night, which seems hardly compatible with the rest essential to a sick patient.

A moderate degree of pyrexia and a raised pulse-rate are usually present for several days after operation owing to absorption of blood from the pleural cavity. The most anxious period is from the seventh to the fourteenth day, when the bronchus may open. The occurrence of persistent cough, particularly if associated with expectoration of thin fluid, is the usual indication of bronchial fistula formation, and it is advisable to insert an intercostal tube without delay, as there is a considerable risk of flooding of the opposite lung; even if this should not occur, infection of the pleural exudate invariably happens sooner or later.

Those patients who heal by first intention are often sufficiently well to sit out of bed by the sixteenth day, and gradually improve their capacity for exercise. Even if a bronchial fistula forms and the pleura is drained, the cavity gradually contracts and healing will take place without any plastic procedure upon the chest wall, although the process of obliteration can be assisted by diaphragmatic paralysis.

Sufficient experience has now accumulated to show that the great majority of carcinomas of the bronchus can be diagnosed during life, and that full investigation is necessary if the diagnosis is to be made at an early stage. Further, that in order to eradicate the disease successfully, complete dissection pneumonectomy is essential. Lastly, that this procedure is not only possible but is followed by such anatomical and physiological adjustments as will permit a life of reasonable activity to the patient.

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A CASE OF ŒSOPHAGEAL POLYPUS ACCOMPANIED BY A TUMOUR OF AN ACCESSORY THYROID GLAND

By E. C. CHITTY, Perak, F.M.S.

Œsophageal polypi are of sufficient rarity to make the following case record of interest :—

CASE REPORT

History.—A Chinese male, aged 26 years, was admitted to hospital on September 1, 1937, for treatment of a large fleshy mass protruding from the mouth. He gave a history of having had a large swelling on the right side of his neck for some years. On the evening of the day preceding admission he had a severe fit of coughing, during which the mass had shot out of his mouth and remained hanging there. After this happened the swelling in the neck became smaller, but did not disappear.

On Examination.—He was seen to have protruding from the mouth a long red fleshy mass, with a velvety surface and a soft flabby consistence, projecting 7 in. beyond the incisor teeth, about 2 in. in diameter, and with a rounded end. There were one or two clefts on the surface. At first sight it resembled an enormously swollen tongue, but on lifting it up the normal tongue was seen beneath it. The posterior attachment of the mass could not be reached digitally. On the right side of the neck there was a soft semi-fluctuant tumour about the size of a tennis ball. The accompanying photographs show the condition clearly (*Figs.* 141–143).

Diagnosis.—From the history it seemed probable that there was some connection between the tumour on the right side of the neck and the mass hanging out of the mouth, but at operation this was found not to be the case. A provisional diagnosis of acute inversion of a pharyngeal pouch was made, but subsequent examination of the excised mass proved this to be incorrect.

Operation.—Under local novocain anæsthesia a laryngotomy was first performed, the incision having to be made well to the left of the midline owing to displacement of the larynx by the neck tumour. General anæsthesia by ether was then induced through the laryngotomy tube. An oblique incision was made on the right side of the neck over the swelling, which was found to be a soft solid encapsulated tumour with some large vascular connections, but with no communication with the pharynx at all.

After removal of the tumour the distorted parts resumed their normal relations, and this caused the laryngotomy tube to become so oblique that it slipped out and gave rise to some anxiety, as the patient stopped breathing and the airway became choked with blood. A rapid attempt to find the original opening failed, and tracheotomy was promptly done and a fresh tube inserted. Anæsthesia then proceeded normally after aspiration of the blood from the air-passage with a suction apparatus and the use of artificial respiration for a few moments.

An incision was made in the right side of the œsophagus, and a long pair of forceps passed from the œsophageal incision out through the mouth to seize the end of the protrusion, which was then withdrawn through the neck wound. The mass was excised, and the site of origin at the junction of the pharynx and œsophagus posteriorly was repaired with catgut sutures from within. The œsophagus appeared to be of normal size below the pedicle. The incision in the œsophagus was then closed with two layers of interrupted catgut sutures, and the neck wound sutured with drainage after swabbing with 1–1000 flavine.

Post-operative Course.—The tracheotomy tube was removed on the second day and the drains on the third day. Injections of soluseptasine were given for three days to try to prevent septic infection.

On the fifth day the wound was obviously septic, and all stitches except those in the œsophagus were removed and much foul pus escaped. Fortunately the wound cleaned up rapidly with dilute hydrogen peroxide irrigations, and healed up slowly from the depths. Final healing occurred on the fiftieth post-operative day.

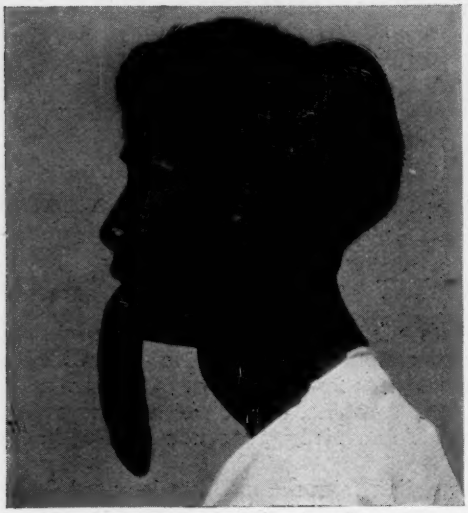

FIG. 141.—Photograph of the patient on admission. Side view, showing the tumour of the neck.

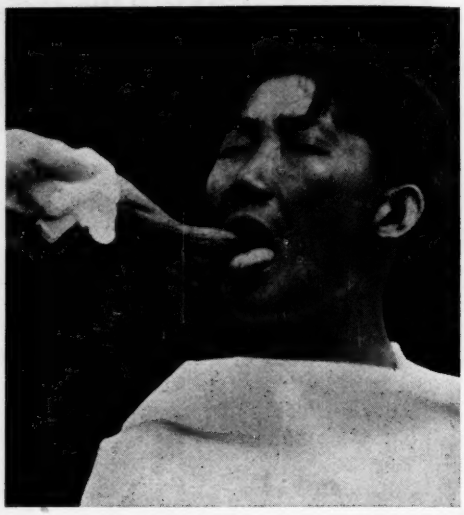

FIG. 142.—Showing the normal tongue beneath the protrusion.

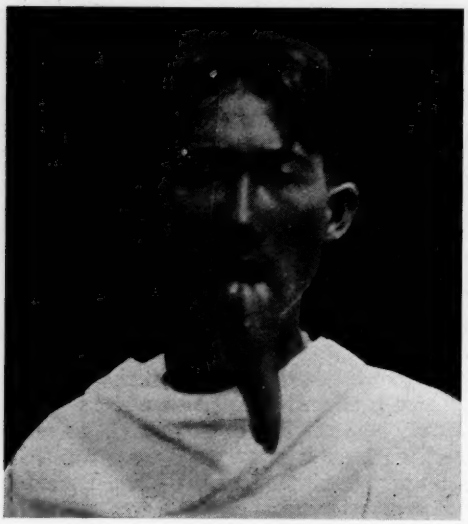

FIG. 143.—Front view, showing the tumour on the right side of the neck.

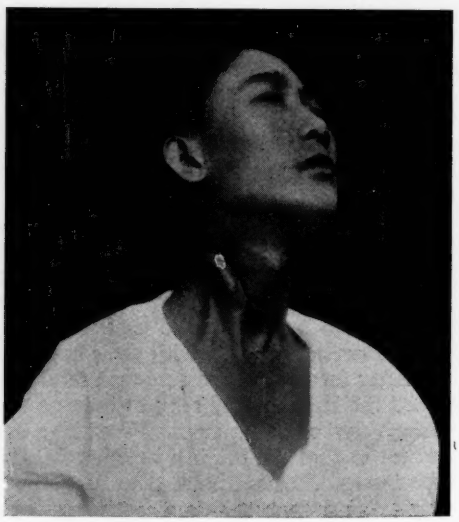

FIG. 144.—The patient on discharge from hospital.

Considerable time could have been saved and a much better cosmetic result have been obtained if the patient had not refused secondary suture.

Barium radiography was done on October 19, 1937; it showed slight antero-posterior narrowing at the site of origin of the polypus, but no obstruction to the passage of the barium.

The patient was discharged on October 21, 1937, able to take solid food without difficulty. The photograph, *Fig.* 144, shows the condition at the time of discharge.

PATHOLOGICAL REPORT.—

1. *The Solid Neck Tumour* (*Figs.* 145, A).—Sections show the tumour to consist of thyroid tissue surrounded by a definite capsule. A considerable amount of colloid is present. In parts the thyroid tissue is atrophic and lying in fatty tissue. In other parts dense fibrous tissue traverses the thyroid tissue. (This fibrous tissue is so dense that it was necessary to treat it with formic acid to enable sections to be cut.)

There is no evidence of malignant change. Presumably the tumour is an accessory thyroid.

A B

FIG. 145.—The specimens after excision, photographed beside a foot rule. A, The solid tumour removed from the neck; B, The œsophageal tumour. Some shrinking has occurred due to preservation in formalin solution.

FIG. 146.—Surface layers of œsophageal polyp with two small diverticular extensions of deep groove on surface. (× 4.)

FIG. 147.—Surface epithelium and subepithelial vascular tissue of the œsophageal polyp. (× 180.)

2. *The Œsophageal Tumour* (*Figs.* 145–148).—The histological features of the specimen are as follows: (*a*) The lining is stratified epithelium. (*b*) The corium is loose œdematous fibrous tissue in which lie many thrombosed vessels, several foci of lymphoid cells, and scanty diffuse infiltration with lymphoid cells. (*c*) Muscular elements in the wall are scanty.

REVIEW OF PREVIOUSLY REPORTED CASES

Vinson (1922) reported a case in a man of 62, who repeatedly regurgitated and swallowed the polypus, but who had no dysphagia at any time. In this case the

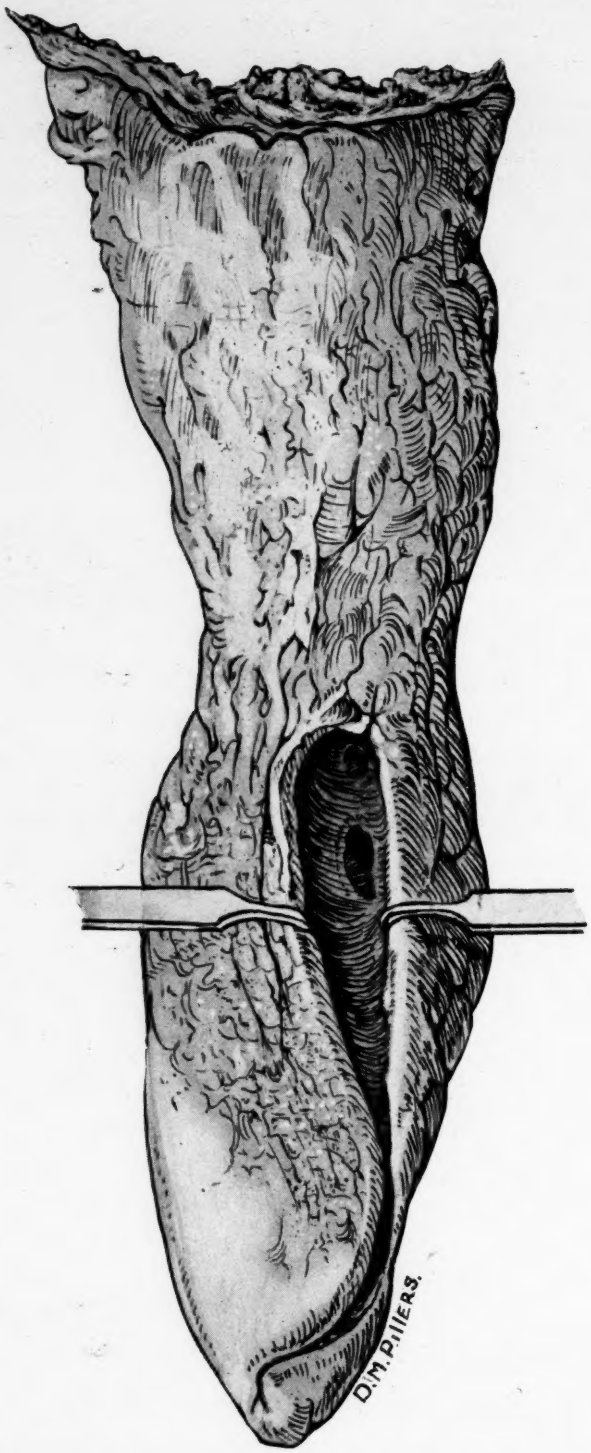

FIG. 148.—A drawing of the œsophageal tumour made from the specimen. (*Natural size.*)

polypus projected 11·5 cm. from the teeth, and was 22·5 cm. in length after excision through a left œsophagotomy. The origin was on the right side of the œsophagus just below the introitus. The tumour was found to be a simple lipoma.

Dyke (1927) reported a case in a woman of 50, who suffered from repeated vomiting and extreme emaciation, and who was diagnosed as a case of œsophageal stricture on radiological evidence. A gastrostomy was done, but the patient continued to go downhill and died. Autopsy revealed an enormously dilated œsophagus containing a polypus attached to the anterior wall at the level of the cricoid cartilage and extending to the cardiac orifice, through which it protruded. The length was 20 cm. and the polypus showed a deep cleft. The histological examination showed œdematous areolar tissue with a covering of squamous epithelium, and the nature of the tumour was described as a "simple polyp". The present case seems to be a myxofibroma.

Dyke, quoting Osler and McCrae, gives the earliest case of removal of such a polyp by the oral route as being recorded by Monroe in 1763. He gives references to 11 cases, mostly in foreign journals.

My thanks are due to Dr. R. D. Fitzgerald, Adviser, Medical and Health Services, Federated Malay States, and to Dr. J. C. Carson, Acting State Medical and Health Officer, Perak, for permission to publish the case, to Dr. R. Lewthwaite of the Institute for Medical Research, Kuala Lumpur, for the pathological examinations, and to Dr. I. Dickson, Medical Officer in Charge of Radiology, Ipoh, for the X-ray examination.

I also wish to express my indebtedness to Professor Hey Groves for helpful criticism and assistance in tracing previously recorded cases, and to Professor T. B. Davie, of Bristol, and Professor J. Beattie, of London, for further pathological investigation of the excised polypus.

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SHORT NOTES OF RARE OR OBSCURE CASES

AN UNUSUAL FINGER ACCIDENT

By THOMAS MOORE

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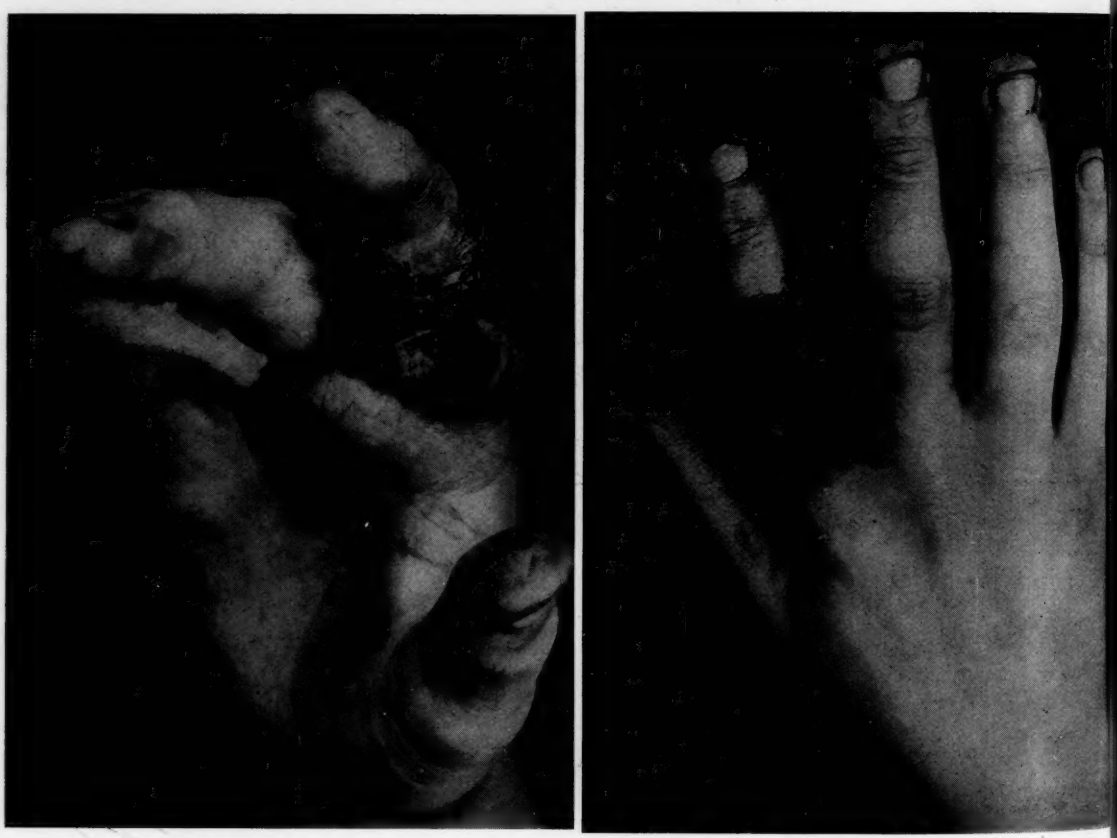
In spite of the great variety of accidents reported, it is felt that the following must be unique :—

History.—J. L., age 14 years, was employed as a polisher by a firm of engineers. On Nov. 3, 1937, he was engaged in cleaning $\frac{7}{8}$-in. nuts; this he accomplished by holding a piece of emery paper against a nut while it was rotating rapidly in an electrically driven machine, round a vertical axis through its centre. During this manœuvre his finger slipped and owing to the thread was rapidly drawn into the rotating nut. The machine was immediately stopped and the nut released firmly screwed on to his finger.



Figs. 149, 150.—Photographs showing the nut firmly screwed on to the index finger, and the lacerated condition of the soft tissues.

ON ADMISSION.—I saw him two hours later in the Manchester Royal Infirmary. The clinical findings were: A healthy youth. Temperature and pulse normal. A large nut had been screwed as far as possible on to the right index finger (*Figs.* 149, 150). The soft tissues on the proximal phalanx had been lacerated and an irregular flap of skin turned back on each side. The finger distal to the nut was pale and slightly cyanotic. It was quite cold and insensitive.

OPERATION.—Three hours after the accident the nut was removed under general anæsthesia. The nut was held in a vice which had been fixed to the arm extension of the operation table. The finger distal to it was covered by a sterile

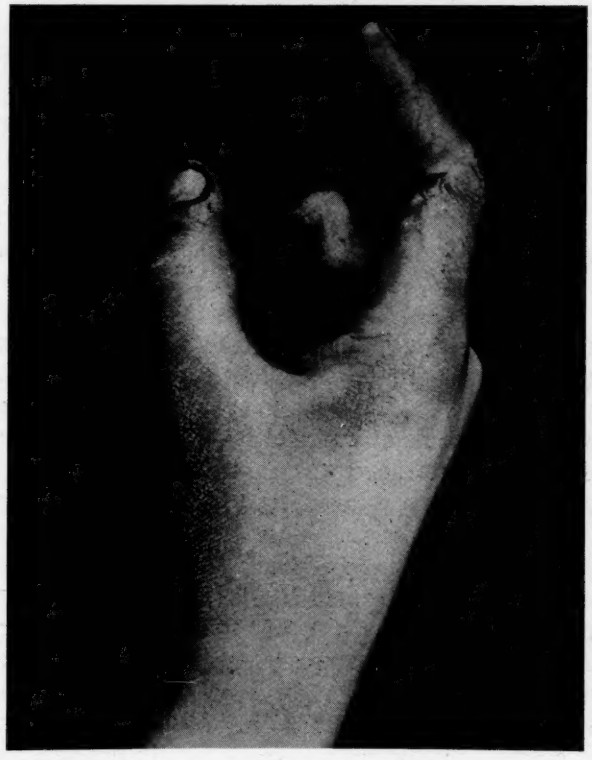


FIG. 151.—Photograph showing the healed finger six weeks after operation.

finger-stall to prevent as far as possible contamination of the lacerated surfaces with metal dust. The nut was removed by cutting through it at two diametrically opposite points, using an ordinary hack saw. The finger immediately became warm and red. The wound over the proximal phalanx was carefully excised and swabbed with acriflavine (1–1000). Although the vitality of the irregular flaps was doubtful, it was decided to replace them in the hope that at least part would survive, rather than obtain new skin by temporary implantation of the finger into the abdominal wall, owing to the possibility of sepsis.

Partial sloughing of the flaps occurred, but the part remained aseptic. Healing was complete in six weeks (*Fig.* 151). The patient has been doing full work since, and the finger is normal.

It is a pleasure to record my indebtedness to Mr. Rayner, under whose care the patient was admitted, for permission to make this report.

PRIMARY SOLITARY DIVERTICULITIS OF THE CÆCUM

By A. J. GRACE, London, Ontario

In a recent number of the British Journal of Surgery, Mr. M. J. Bennett-Jones[1] reported three cases of this condition as well as collecting seventeen recorded cases from the literature. It was noted that tuberculosis of the cæcal wall appeared to be an aetiological factor in isolated instances. The following is an account of a recent personal case of right-sided abdominal symptoms arising as a result of an inflammatory process in a diverticulum of the acquired or false type. Healed tuberculosis of the regional lymph-glands was found in this case, without any tuberculous lesion of the cæcum.

The patient was a male, aged 40, Scotch, single, a farm labourer at the local Sanatorium, who was admitted to hospital as a case of acute appendicitis on October 30, 1937.

History.—Previous health always normal except for some rather indefinite 'indigestion' (vague, generalized abdominal discomfort occurring about two hours after large meals) for the last few months. Although not consulted professionally, his medical attendant saw him about the institution from time to time and felt that there had been a recent loss of weight, together with some deterioration of the general condition. The patient admitted feeling a little below par the preceding night, and taking 'a dose of salts'. Definite symptoms commenced about fourteen hours before admission, when he awoke shortly after retiring with a dull but severe pain in the right iliac fossa, associated with some discomfort in the umbilical region. After three hours the pain became less severe, although it persisted as a localized, steady ache up to the time of admission. There was no nausea or vomiting. The pain showed no radiation. No disturbance of the bowel or bladder functions took place.

On Examination.—General aspect healthy; tongue slightly furred, moist; pulse 74; temperature 99·2°; leucocyte count 15,850, with 86 per cent polymorphs, of which 9 per cent were immature forms; general deportment in bed in keeping with an early acute appendicitis. The right lower quadrant of the abdomen showed a little limitation of the respiratory excursion. No true rigidity was present, but palpation revealed a small, tender mass situated deeply beneath McBurney's point. This was taken to represent an inflamed appendix separated from the parietal peritoneum by adherent omentum, although the shortness of the history appeared to cast doubt on this interpretation. Rectal examination yielded normal findings.

Operation.—The right lower abdomen was explored through a gridiron incision. The appendix was not grossly abnormal. A number of firm lymph-glands, ranging in size up to that of a hazel-nut, were felt in the ileocolic region. No Meckel's diverticulum was present, and the terminal ileum was normal. Palpation revealed an indurated mass, about the size and shape of the yolk of a fried egg, involving the posterior wall of the cæcum. Although not accessible to inspection, this was taken to be carcinomatous, with superadded inflammation; tuberculosis of the hyperplastic variety seemed much less likely. The liver edge came down nearly three finger-breadths below the costal margin, but otherwise the organ was normal.

A right hemi-colectomy was performed in two stages. The first stage consisted in an end-to-side ileo-transverse colostomy through a separate right lower

paramedian incision. Ten days later the colon as far as the middle third of the transverse portion was resected, together with the stump of the ileum; this was done through an oblique incision placed parallel to the intercostal nerves. At this second stage it was noticed that the tumour mass appeared to have diminished considerably both in size and in the amount of induration. This change was ascribed to subsidence of the inflammatory element following the unilateral exclusion operation.

POST-OPERATIVE COURSE.—Recovery was uneventful apart from a mild wound infection following the last operation. He was discharged from hospital after a month. When last seen six weeks later he was free from symptoms and had returned to light work. It is regrettable that he has absolutely refused to undergo further investigation, which was proposed in the hope of finding or excluding diverticula of the left colon, or tuberculous disease elsewhere.

EXAMINATION OF SPECIMEN AND PATHOLOGICAL REPORT.—The following is an abstract of the essential, positive findings reported by Dr. J. Fisher: "Midway between the ileocæcal valve and the opening into the appendix there is a small diverticulum of the cæcum. This pouches into an œdematous and somewhat indurated portion of the subserous tissue." Microscopic examination of "a section taken through the indurated, œdematous pericæcal tissue shows a sacculated diverticulum of the cæcum extending into the subserous tissue. About the diverticulum there is a pronounced inflammatory reaction, as shown by marked congestion of the vessels, œdema, pronounced cellular infiltration, multiple small areas of necrosis, and abscess formation, as well as a well-marked organizing peritonitis." There was "a well-marked muscularis mucosæ, but . . . no muscularis", meaning a diverticulum of the 'false' type.

The appendix and other portions of bowel removed were normal. The mesenteric lymph-glands showed no evidence of malignancy or of active tuberculosis, but some did show apparently healed calcified tuberculosis.

REFERENCE

[1] BENNETT-JONES, M. J., "Primary Solitary Diverticulitis of the Cæcum: a Report on 3 Cases, with a Review of 17 Recorded Cases', *Brit. Jour. Surg.*, 1937, xxv, 66.

CARCINOMA OF THE STOMACH AND THE RECTUM IN THE SAME PATIENT

BY J. JEMSON
DEPUTY MEDICAL SUPERINTENDENT, ST. ALFEGE'S HOSPITAL, GREENWICH
AND E. G. SLESINGER, O.B.E.
SURGEON TO GUY'S HOSPITAL

H. H., female aged 53 years, was admitted to St. Alfege's Hospital on March 30, 1932, suffering from abdominal pain and vomiting.

She gave a history of abdominal pain accompanied by vomiting coming on about two hours after taking food. This dated back for five years, the symptoms gradually increasing in severity, and more recently a considerable amount of weight had been lost. She had no longer any desire for food.

She was a very thin woman, who had obviously lost a considerable amount of weight. Radiography of the stomach with barium showed a deformity in the

pyloric end of the stomach, more suggestive of a carcinoma than a chronic ulcer. A fractional test-meal showed a good amount (60 per cent) of free acid.

FIRST OPERATION.—Laparotomy was performed on April 4, 1932 (J. J.). A mass about the size of a golf ball was present in the pyloric end of the stomach. The only evidence of glandular enlargement was in the sub-pyloric group, and this was only moderate, and not obviously carcinomatous. There was no evidence of any secondary deposits.

Partial gastrectomy by the Polya-Moynihan method was performed, two-thirds of the stomach being removed. A satisfactory recovery was made and the patient was discharged on May 27.

HISTOLOGICAL REPORT.—The specimen removed showed ulceration of the gastric mucosa, and the report reads as follows: "There is increase in the fibrous tissue, and much inflammatory reaction: further, infiltrating the fibrous tissue are columns of epithelial cells in a disorderly arrangement. Histological diagnosis: scirrhous carcinoma of stomach."

The history, in conjunction with the above report, would suggest that this was an 'ulcer cancer'.

SUBSEQUENT HISTORY.—Six months later she presented herself with a marked anæmia and a lemon-tinted skin. The Hb was 40 per cent; the C.I. 0·45. This anæmia responded to treatment with liver and iron preparations.

On February 5, 1934, the patient was again admitted to hospital, this time complaining of passing blood per rectum. Rectal examination revealed an indurated ulcer low down in the rectum. A diagnosis of carcinoma of the rectum was made. The Hb was 76 per cent and the C.I. 0·83.

SECOND OPERATION.—A laparotomy revealed no evidence of secondary deposits in the abdomen, and so a left inguinal colostomy was performed. After a short interval, a blood transfusion was given, and this was followed by a perineal resection of the rectum (E. G. S.) on March 22, 1934.

The growth was found to be low down in the rectum, and to extend only half way round the gut.

HISTOLOGICAL REPORT.—Columnar-celled carcinoma of rectum.

SUBSEQUENT PROGRESS.—The present condition of this woman is very good. She enjoys life, and since her operations has gained a considerable amount of weight. Her appetite is good, and the colostomy is well regulated and causes her very little trouble. The Hb is now 92 per cent.

Comment.—The chief points of interest in this case are:—

1. The patient has survived after resection of a carcinoma of the stomach for almost six years.

2. She is also alive and well almost four years after a resection of the rectum for carcinoma.

3. Recovery for so long a period after two such major operations for carcinoma in different organs must be unusual, particularly when one of them is the stomach.

We are indebted to the Medical Officer of Health for London and to the Medical Superintendent of St. Alfege's Hospital for their kind permission to publish this case.*

* Since the above was written, this patient was re-admitted suffering from pneumococcal peritonitis, and died the same day. A detailed post-mortem examination showed no signs of carcinoma.

REVIEWS AND NOTICES OF BOOKS

Practical Procedures. Edited by Sir HUMPHRY ROLLESTON, Bt., G.C.V.O., K.C.B., M.D., F.R.C.P., and ALAN A. MONCRIEFF, M.D., F.R.C.P. With a Preface by Sir DAVID WILKIE, O.B.E., M.D., M.Ch., F.R.C.S., F.A.C.S., F.R.S.E. Demy 8vo. Pp. 293, with 66 illustrations. 1938. London: Eyre & Spottiswoode (Publishers) Ltd., for *The Practitioner*. 10s. 6d. net.

THIS book will prove of the greatest value to Hospital Residents who begin to apply in practice the principles instilled whilst yet students. Here they will find those details so important in every undertaking, but the significance of which they seldom realize or clarify until faced with the responsibility of their own unaided action. For study and reference alike it will be extremely valuable. To the practitioner keen on the technicalities of his profession it will likewise be a guide and stimulus, whilst to those who practice in the more localized fields of consulting practice the opportunity will be welcomed of again reading of exact methods and recalling details. As Sir David Wilkie aptly puts it in his introduction, "to all who have any flair for using their hands" this book will be of exceptional interest.

There are seventeen chapters in the book and it would be invidious to pick out one from another where all give the results of some special experience and expert knowledge. The important feature all through is the detailed accounts of procedures. A wide field is covered, beginning with the application of plasters. The administration of fluids, with a discussion on the signs and symptoms of dehydration, is especially interesting because of the reference to Murphy's original papers and the detailed and illustrated description of correct proctoclysis.

Blood transfusion is next dealt with. The Dewar flask is advised as simple, generally adaptable, and reliable. Reactions, their avoidance and treatment, are clearly set out. The technique of blood-counts is emphasized by the interpretation of findings discussed from illustrative cases. Poisoning, the taking of the blood-pressure and its relations to life assurance, and the indications for and technique of pleural aspiration, are all important subjects dealt with from the practitioner's standpoint. Practical points are considered in discussing the use of two-way or three-way syringes, whilst in catheterization a plea is made for the metal catheter. The remarks on drainage of the bladder are to be pondered over. Too often this serious step is lightly undertaken with a disregard to attention to detail which is fatal to that maintenance of asepsis which is here so wisely emphasized.

The clinical examination of the urine, circumcision in children, injection treatment—all are subjects of the greatest value to general practitioners and in themselves justify the commendation which Sir David Wilkie gives to the background of the book. Minor surgical infections of the skin covers useful ground, whilst "local anæsthesia" advocates percaine, giving three excellent reasons for doing so. Eye, nose, and urethra are not excluded. Common minor soft tissue injuries and their treatment should prove of the greatest value, dealing as it does with just those conditions commonly met with in practice. Lumbar puncture and syringing the ear are the two final chapters which round off a book which is useful, clear, and exact.

There is remarkably little overlapping. We note that in anæsthetizing the urethra in one place three ounces of ½ per cent cocaine is advised and in another half an ounce of a like strength. The latter is to be recommended.

There are useful illustrations and an index.

Praktikum der Chirurgie. Ein Leitfaden für Studenten und Ärzte. By Prof. Dr. O. NORDMANN, Berlin. Fourth edition. 10½ × 7¼ in. Pp. 811 × xvi, with 409 illustrations, some coloured. 1938. Berlin and Vienna: Urban & Schwarzenberg. RM. 25; bound, RM. 27.50.

THIS text-book of practical surgery, now appearing in its fourth edition, is intended to bridge the gap between the theoretical teaching of surgery in the University and the practical study of clinical problems at the bedside. The body of the work consists of twenty-nine chapters

describing in a systematic way the technical procedures of surgery, the injuries, and the diseases of the various tissues and organs. The description of osteomyelitis is short, but very clear, and the views expressed about treatment are on sound lines, avoiding the extremes of radicalism and conservatism. The article on fractures is confined to forty-seven pages and rather disappointing in some respects. For example, the advice about fractured neck of the femur leaves one quite uncertain as to what course to adopt, as the author is quite sceptical about modern nailing methods and offers no clear alternative advice. The chapters on thoracic and abdominal surgery are clear and concise and offer no special points for comment. The book concludes with three chapters devoted to operative surgery, and this section is more freely illustrated than the body of the work. These figures are very clear and instructive.

The whole book represents a clear and well-arranged exposition of the subject, in which good judgement has been shown in the emphasis laid upon the essential facts of diagnosis and treatment.

Clinica y Terapéutica quirúrgicas de Urgencia. By M. CORACHÁN GARCIA and F. DOMÉNECH-ALSINA, Barcelona. Large roy. 8vo. Pp. 744 × xii, with 255 illustrations, some coloured. 1937. Barcelona: Editorial Labor, S.A.

THIS excellent book by two surgeons of the Faculty of Medicine of Barcelona would be well worth translation into English. It does not include fractures nor the emergencies proper to the ophthalmologist or otorhinologist, but otherwise the whole field open to the general surgeon is covered, and covered in a thoroughly practical and up-to-date fashion. It is particularly noteworthy that, instead of merely relating half-a-dozen procedures, with the name of the protagonist attached, leaving choice to the reader, these authors state what they consider the proper treatment, and afterwards outline alternative methods, with the arguments put forward for their adoption by those who favour them. It is, therefore, a much more useful book than many Italian and German works, which compile information, but fail to instruct.

Testing a dozen subjects at random, the advice given seems to be thoroughly sound, sensible, and practical. It is possible, of course, to pick holes on small points and to disagree as to the value of some methods, but in general the indications are those favoured in the best European and American clinics. It is worth mentioning that the citations of recent literature include a large number from books and papers by British surgeons.

Altogether an admirable and very useful volume.

Emergency Surgery. By HAMILTON BAILEY, F.R.C.S. (Eng.), Surgeon, Royal Northern Hospital; Surgeon and Urologist, Essex County Council; Surgeon, Italian Hospital. Third edition. $8\frac{7}{8} \times 6\frac{1}{8}$ in. Pp. 852 + xii, with 816 illustrations, of which a large number are in colour. 1938. Bristol: John Wright & Sons Ltd. 50s. net.

THIS, the third edition, continues to merit the very favourable opinion we expressed in our review of the two volumes of the first edition. Like the second, this edition is condensed into one volume, of 852 pages; the text has been extensively revised, some new illustrations have been added, and certain of the sections have been rewritten. The whole has been brought thoroughly up to date, and we can recommend this work as an excellent guide to the technique of, and the indications for, the surgical operations of emergency.

Surgical Errors and Safeguards. By MAX THOREK, M.D., K.L.H. (France), K.C.I., Professor of Clinical Surgery, Cook County Graduate School of Medicine; Surgeon-in-Chief, American Hospital of Chicago; etc. With a Foreword by ARTHUR DEAN BEVAN, M.D., Professor and Head of the Department of Surgery, Rush Medical College of the University of Chicago. Third revised edition. $10\frac{1}{2} \times 7$ in. Pp. 696 + xv, with 668 illustrations, a number in colour. 1938. London: J. B. Lippincott Co. 45s. net.

THIS work, first reviewed in this JOURNAL in October, 1932, has evidently been favourably received by the medical profession, and is now in its third edition. Since Lister's day surgical technique has made such rapid strides that in well-staffed and well-equipped hospitals it has become more or less standardized. Grave errors in the technical performance of surgical

operations are, consequently, becoming steadily fewer, and present-day failures in surgery result mainly from 'imponderable' factors—particularly errors in our judgement of a patient's resisting powers to withstand shock and other general effects of operative procedures.

Everywhere the author wisely stresses the employment of all known methods of safeguard against such effects, not only during but also prior to and succeeding the actual operation itself. The present edition has been thoroughly revised and brought up to date, and we can warmly recommend its study by all progressive surgeons.

Diagnostisch-therapeutische Technik für den Chirurgen. By Dr. med. RUDOLF GEISSENDÖRFER, Breslau. With an Introduction by Professor Dr. K. H. BAUER, Breslau. Demy 8vo. Pp. 509 + xxiv, with 148 illustrations and 2 coloured plates. 1937. Leipzig: A. Barth. RM. 16; bound, RM. 18.

THIS book gives an account of many subjects not usually described in the ordinary textbooks of surgery. The chapters on clinical pathology and biochemistry are arranged according to the usual clinical systems. Details of the methods which the general practitioner himself can apply are given in detail; whereas, for the more intricate tests, the methods of collection of clinical specimens, the normal range of figures, and the significance of deviation from the latter are given.

Details of major operative technique are omitted, but numerous minor procedures, which the house surgeon or general practitioner may be called upon to employ, are fully described. The methods described are mostly those of the Breslau chirurgische Universitätsklinik, where Dr. Rudolf Geissendörfer is the senior assistant surgeon.

The greater part of the book is concerned with pre-operative and post-operative treatment. Dietetic, medicinal, and nursing treatment are extensively described. The chapters relating to the gastro-intestinal tract and thyrotoxicosis are among the most interesting. The section on blood transfusion is full of technical details, some of which seem to us to be rather crude. For instance, the method of Dr. Bürkle de la Camp, by which the operator appears to blow down a rubber tube connected to the chamber containing the blood, seems to be a method that we should be ashamed to employ. Dr. Geissendörfer describes a method of transfusion in which blood is collected in an amber container. It is interesting to learn that no citrate is required, owing to the claim that blood does not clot in an amber vessel.

Short chapters are devoted to general and local anæsthesia and their complications. Like most Continental surgeons, Dr. Rudolf Geissendörfer seems to lay too great a stress upon the use of local anæsthesia, and it is interesting to note that gas and oxygen is hardly ever employed at his clinic.

The bibliography relating to the various sections is given at the end of the book, and supplies a useful index of the recent German surgical literature.

This work may be a useful vade-mecum for a German house surgeon or young surgically-minded practitioner.

Textbook of Experimental Surgery. By J. MARKOWITZ, M.B. (Tor.), Ph.D., M.S. (Minn.), Research Associate, Department of Physiology, University of Toronto; formerly Professor of Physiology, Georgetown University School of Medicine, Washington, D.C. $9\frac{1}{2} \times 6\frac{3}{4}$ in. Pp. 528 + xvi, with 330 illustrations. 1937. London: Ballière, Tindall & Cox. 31s. 6d.

IN this country experimental surgery is confined strictly to investigative work, undertaken with the sole object of advancing knowledge in medicine in its widest sense. In America experiments on animals are carried out with the dual object of advancing medicine and training the student and young graduate in operative manipulation and technique.

Dr. Markowitz, who has worked for some years in the admirably equipped and progressive Department of Experimental Surgery at the Mayo Clinic, has produced this valuable treatise on the methods and technique which have been employed, and in many cases evolved, in that Department. He seeks to prove, and in effect he succeeds in proving, that the well-trained surgeon must approach his work with a mind steeped in physiology.

The opening chapters on operative technique require no comment—they are such as we find in any text-book of operative surgery; those on intestinal fistulæ, experimental peptic ulcer, and biliary fistulæ, however, reflect the original work of the Mayo laboratory and are full of interest. The surgery of the involuntary nervous system is well described, and a particularly valuable chapter is that on experimental surgery of the liver.

This book will be welcomed by all working in surgical research departments. It does not pretend to be encyclopædic or comprehensive, and reflects American rather than world-wide experience in experimental surgery. It has the great advantage that it describes and illustrates methods which the author has tried out, and thus bears the hall-mark of personal experience. It can confidently be recommended to all who are studying, and who intend to practise, surgery.

Surgical Anatomy of the Head and Neck. By JOHN FINCH BARNHILL, M.D., F.A.C.S., LL.D., formerly Professor of Otolaryngology in the Indiana University School of Medicine; etc. Introduction by PAUL F. MCKIBBEN, Professor of Anatomy in the Medical School of the University of Southern California. 10¼ × 7½ in. Pp. 921 + xiii, with 431 illustrations, some in colour. 1937. London: Ballière, Tindall & Cox. 90s. net.

THIS book is based upon courses of post-graduate teaching in otolaryngology which were given by the author over a period of many years. Repeated requests from former post-graduate students resulted in its publication.

Otolaryngology is dealt with in more detail than other aspects of the surgery of the head and neck. The whole subject is approached from the anatomical point of view.

The exposition of the detailed anatomy of the cranial nerves, the accessory sinuses of the nasal cavity, and the cells of the mastoid process in relationship to the surgery of those regions is extremely helpful.

The appeal of the work is certainly to those interested in ear, nose, and throat surgery, rather than to the general surgeon.

One must criticize the general arrangement of the text and illustrations. The test is presented first as a series of lectures, which occupy the first half of the book; these are followed by the illustrations, comprising the latter half. It is always more helpful to have a narrative and its corresponding illustration side by side.

Of the illustrations themselves, the diagrams and line drawings are excellent and are infinitely preferable to the photographs and sketches. The photographs were probably taken some years ago. The sketches are indistinct and convey a very hazy impression of the points they are intended to illustrate.

It is felt that one would have gained much more by attending the author's post-graduate course on these subjects—illustrated as they were by anatomical specimens and dissections and blackboard drawings—than one does by perusing the present volume.

Surgical Diseases of the Mouth and Jaws. By EARL CALVIN PADGETT, B.S., M.D., F.A.C.S., Associate Professor of Clinical Surgery, University of Kansas School of Medicine, Kansas City; Associate Professor of Oral Surgery, Kansas City Western Dental College. 9½ × 6½ in. Pp. 807, with 334 illustrations. 1938. London and Philadelphia: W. B. Saunders Co. Ltd. 45s. net.

THIS is a large book which covers all diseases of the mouth, pharynx, and sinuses. Immense labour must have been necessary to collect the very full information on every conceivable condition which is here set forth. As a work of reference for the general surgeon it will prove almost invaluable. If, by chance, he should not find sufficient details about the particular subject in which he is interested, he will at any rate be able to consult original sources, for many references appear at the end of each chapter. The author is content to cite the opinions of authorities in many cases without criticism, leaving it to the reader to evaluate them. He is by no means dogmatic or assertive in laying down rules for the management of many diseases he discusses. He debates very fairly the question of the treatment of the neck in malignant disease of the mouth, and does indeed here give his own views. He takes up a "three-quarter" position from routine surgical attack on the lymphatic area when no glands are palpable. Unfortunately, he is not very precise in defining which quarter of patients it is advisable to attack by surgery. From his very interesting discussion he obviously relies upon

a clinical acumen which it is quite impossible to impart to others. He could do no more, for we have neither the biological knowledge nor the statistical information which would justify us in assuming an unchallengeable attitude towards this problem. Block dissection, interesting to note, he does under local anæsthesia, takes thirty-five minutes over it, and regales the patients with a cup of coffee at its completion.

This is indeed a very useful work of reference, and deserves a place in the library of every general surgeon. It is well indexed and well illustrated.

Speech Training for Cases of Cleft Palate. By M. C. OLDFIELD, M.Ch. (Oxon.), F.R.C.S. Cr. 4to. Pp. 20 + iii, with 38 illustrations. 1937. London: H. K. Lewis & Co. Ltd. 4s. 6d. net.

FROM the contents of this book it is difficult to see what object the author had in mind in its publication, since it can hardly be regarded as a text-book for those who are undertaking the training of cleft-palate cases, nor can it be regarded as a contribution to the subject of importance.

As Mr. Oldfield states in his introductory remarks, however, the book may well be useful to the ambitious mother and the intelligent adult patient, since it gives some quite reasonable explanations of the methods of sound formation, which could well be recommended to the lay person who has the responsibility of a cleft-palate child.

In any case, it is refreshing that a practising surgeon should take so much interest in speech rather than in mere material cosmetic results.

Fractures and Dislocations for Practitioners. By EDWIN O. GECKELER, M.D. 9 × 6 in. Pp. 252 + x, with 213 illustrations. 1938. London: Ballière, Tindall & Cox. 18s.

THIS small book is remarkable for two features—its compact size, and the wealth of information packed into this small compass. It represents the modern views on the subject, including the importance of reduction under X-ray control and the treatment by traction and plaster-of-Paris fixation. Special emphasis is laid on rehabilitation by suitable work and exercises. As a rule only one method of treatment is described for each fracture. This has its advantages, except when, as in the case of the neck of the femur, the method is an unusual one (the insertion of two screws, instead of the widely accepted Smith-Petersen nail).

Whilst we congratulate the author on his skill in compressing the subject into a very small space, we are doubtful whether this sketchy view of the subject serves any really useful purpose.

The Management of Fractures, Dislocations, and Sprains. By JOHN ALBERT KEY, B.S., M.D., St. Louis, Mo., and H. EARLE CONWELL, M.D., F.A.C.S., Birmingham, Ala. Second edition. 10¼ × 6¾ in. Pp. 1246, with 1222 illustrations. 1937. London: Henry Kimpton. 52s. 6d. net.

IN this edition the text has been revised and the sections dealing with fractures of the spine and hip have been re-written. The arrangement of the subject matter follows closely the lines of the first edition.

Many of the methods of treatment described would not find general acceptance in this country. Most British surgeons believe any form of passive stretching of an elbow-joint following injury to be fraught with considerable danger, often leading to serious limitation of movement. It is surprising, therefore, to read that the authors recommend carrying weights or a pail of water with a view to restoring extension in these injuries.

Whilst it is agreed that adequate immobilization of a fracture can usually be obtained only by splinting the joints immediately above and below the injury, it is important that the remaining joints of the limb should be unrestricted. We cannot, therefore, recommend the splintage advocated for certain fractures: for example, a plaster including the fingers for scaphoid and forearm fractures.

The text-book gives a good account of the clinical picture of fractures, and is useful for purposes of reference, but it cannot be recommended to British surgeons as a guide to fracture treatment.

Practical Proctology. By LOUIS A. BUIE, A.B., M.D., F.A.C.S., Head of Section on Proctology, The Mayo Clinic; Professor of Proctology, The Mayo Foundation for Medical Education and Research, Graduate School, University of Minnesota. 9¼ × 6 in. Pp. 512, with 151 illustrations. 1937. London and Philadelphia: W. B. Saunders Co. Ltd. 30s. net.

IN this volume the author has presented in practical form the experience of the Mayo Clinic in its department of proctology during the ten-year period 1925–1934. We congratulate him upon the success of his effort.

The opening chapter deals with the indications for carrying out a systematic and thorough examination of the rectum. It is pointed out that it is wise to assume that every patient who complains of symptoms referable to the rectum should be suspected of suffering from cancer until it has been proved definitely that he is not. This is sound advice, and we cannot help thinking that if it were adopted as a routine measure, many more carcinomata in an early phase of development would be discovered. When speaking of an examination by means of the proctoscope the author insists that the patient should not be anæsthetized. Of the four positions in general use for carrying out of a proctoscopic or sigmoidoscopic examination the inverted position is considered to be far the best, and an illustration of the special table designed to hold the patient in the inverted position is shown.

Chapter II is devoted to anatomical considerations, and contains an excellent account of the disposition of the lymphatics of the rectum. Pre-operative preparation and post-operative care are carefully described in the succeeding chapter. Considerable space is given to a detailed description of the various methods of inducing anæsthesia. We cannot help feeling that this is somewhat out of place in a work of this kind. Excellent advice is given as to how catheterization may be avoided during the first 24 hours of the post-operative period. For control of post-operative hæmorrhage the author is enthusiastic about the efficacy of a "hæmorrhage pack," which is introduced into the rectum through a proctoscope. The method is certainly ingenious, but it seems to us that the pack might become a too efficient cork and convert visible into occult bleeding.

Anal fissure is discussed in Chapter V. Causation is attributed to the anatomical structure of the anal outlet, in consequence of which a small triangular space, situated in the middle line posteriorly, is unsupported by the sphincteric muscles. We cannot subscribe to such an explanation, because if such were the case then every individual would suffer from fissure.

Anal fistula, as it is termed, is dealt with in the following chapter. We do not agree with the statement that "there never has been an anal fistula without a primary internal opening", nor do we recollect having seen a fistulous track that completely encircles the anus. We also wonder what becomes of the nerve-supply to the external sphincter muscle when such an encircling track has been laid open in its entirety, as shown in the illustrations on pp. 152 and 153.

The subject of hæmorrhoids is dealt with at length, and the author's operation, which appears to be a glorified Whitehead, is strongly advocated as the best method. Thirty-three pages of the book are devoted to the consideration of the cause, symptoms, and treatment of pruritus ani, and so far as we have been able to gather nothing has been added to the knowledge we already possess in regard to this troublesome complaint. The subject of ulcerative colitis is very thoroughly considered. Dr. Buie has had considerable experience in dealing with these cases and his deductions are well worth the reader's close study. Amœbic dysentery, bacillary dysentery, balantidiasis, and actinomycosis receive attention in the following chapter, and make interesting reading for surgeons in this country, as they are very rarely met with. Malignant disease receives ample consideration, and the author offers very sound advice when he says: "those surgeons who operate only in those cases in which the lesions are small, movable, not obstructive, and of low grade of malignancy should consider performing radical surgical operations on patients whose condition presents a more difficult technical problem". The right note is also struck when, in answer to those who advocate conservatism in the surgical treatment of cancer, he says: "there should be no interference with modern surgical effort to obliterate all evidence of malignancy by extensive dissection and excision".

The book is well printed and illustrated, and forms a handy volume, the perusal of which we heartily recommend to those who are interested in the subject of proctology.

The Therapeutic Problem in Bowel Obstructions. A Physiological and Clinical Consideration. By OWEN H. WANGENSTEEN, B.A., M.D., Ph.D., Professor of Surgery of the University of Minnesota and Surgeon-in-Chief of the University of Minnesota Hospital. 10 × 6½ in. Pp. 360 + xxi, with 90 illustrations. 1937. London: Baillière, Tindall & Cox. 27s. net.

THIS work is the outgrowth of an essay which was awarded the Samuel D. Gross Prize in 1935 by the Philadelphia Academy of Surgery, and attempts to set forth the important aspects of the therapeutic problem in obstruction of the bowel. It is really a brief digest of Professor Wangensteen's personal experimental investigations and experience in intestinal obstruction.

The first part is almost exclusively taken up by experimental work on dogs, the results of which emphasize the importance of mechanical factors in the development of the harmful consequences of obstruction. Apart from the loss of essential fluids, important in high obstructions alone, the chief factor for concern is the viability off the bowel wall, whether threatened by an increase of intra-enteric pressure or by external constricting agents. High intra-enteric pressure, in a viable obstructed bowel, decreases all absorption from the gut, save through the lymphatics. Only when the bowel wall is non-viable does transperitoneal absorption occur. Little support is given to the toxin theory of death in obstruction of the intestine.

The remainder of the book is concerned with the diagnosis and treatment of various types of intestinal obstruction, each type being discussed separately and fully. Saline infusions are recommended only in high obstructions of the intestine, and the efficacy of blood transfusion in cases in which strangulation has occurred is stressed. Professor Wangensteen's method of duodenal drainage through an inlying catheter is described at length, with a series of interesting cases.

There is a certain amount of unnecessary repetition, perhaps the inevitable accompaniment of the enlargement of an essay into a book; but to those especially interested in this branch of surgery, the book should prove valuable and stimulating. Exhaustive bibliographical references are given.

The Principles and Practice of Rectal Surgery. By WILLIAM B. GABRIEL, M.S. (Lond.), F.R.C.S. (Eng.), Surgeon to St. Mark's Hospital; Surgeon to the Royal Northern Hospital. Second edition. 9¾ × 6 in. Pp. 363 + x, with 9 coloured plates and 162 illustrations. 1937. London: H. K. Lewis & Co. Ltd. 28s. net.

IT speaks well for the popularity of this excellent book that a second edition should have been called for so soon after the appearance of the first. The subject matter has been thoroughly revised, especially the chapters on prolapse, fistula, stricture, and carcinoma. In addition, three new chapters have been added—namely, on surgical anatomy, traumation, and sarcoma.

Succeeding the chapter on anatomy there is an excellent one on rectal diagnosis, comprising hints for making careful investigation of symptoms and adequate examination of the patient. The technique of proctoscopy and sigmoidoscopy is given in elaborate detail.

In discussing hæmorrhoids considerable space is devoted to the consideration of the method of treatment by injection, the technique practised by the author being carefully described. His experience of the method leads him to conclude that in the early stages it is curative, but if employed in the later stage of hæmorrhoidal disease relief of symptoms is obtained only for a time, usually two years.

For the operative treatment of internal hæmorrhoids only one method receives notice—namely, catgut ligature by transfixion. This is considered the simplest and best available. Of the post-operative complications, secondary hæmorrhage is said to occur in about 1 per cent of the cases thus operated upon. The bleeding is readily controlled by plugging the rectum with a rubber tube (½ to ¾ inch in diameter) to which is added a "gauze surround". It is not stated whether it is necessary to anæsthetize the patient when the tube and gauze need to be removed.

Prolapse of the rectum is thoroughly described, and the various methods of treatment that have been from time to time put forward are discussed. The author considers that the best method of treating complete prolapse is by the operative procedure known as recto-sigmoidectomy. The various steps of the operation are well illustrated.

The operation devised and strongly recommended for the surgical cure of a fissure seems to us to be far too extravagant in the sacrifice of healthy skin, with the result that it is replaced by a considerable area of scar tissue.

Thirty-two pages of the book are devoted to the consideration of fistula-in-ano. The classification adopted for these fistulæ, we think, leaves much to be desired. In our view a great deal of confusion of terms results from speaking of high-level and low-level fistulæ as varieties of anal fistulæ. Moreover, it seems curious that a pelvirectal fistula, which has no connection whatever either with the rectum or the anal canal, should be referred to as an anorectal fistula. The details of technique in the surgical treatment of fistula are extremely well described and should be very helpful to the student of proctology.

Pruritus ani, injuries to the rectum, stricture of the rectum, and benign tumours receive adequate attention, the latter being particularly well illustrated.

Carcinoma of the rectum is very thoroughly considered, and is replete with information and sound advice. We concur with the author's statement that the operation of perineal excision fails to eradicate the disease, except perhaps in the earliest cases, because the upward spread usually extends beyond the reach of any operation undertaken from the perineum alone. Of the combined operations the perineo-abdominal is preferred to the abdomino-perineal. In 33 consecutive perineo-abdominal operations there has been only 1 death, an achievement of which the author and his colleagues at St. Mark's may well feel proud. Post-operative treatment of the combined operation is very ably discussed, supreme importance being attached to the method of drip-blood transfusion in all cases. The importance of combating post-operative shock, the supply of chlorides intravenously, and the prevention of dehydration are especially emphasized.

The book is well written and profusely illustrated by excellent drawings. It represents the present-day practice of an authority upon the subject, and cannot fail to be of service to those who are interested in proctology.

Il Cancro della Mammella. Studio Anatomo-patologico e Clinico. By GIAMPAOLO COGGI. Vol. XIII of *Collanà di Attualità chirurgiche* (Diretta da Prof. Mario Donati). 10 × 7 in. Pp. 192, with 42 illustrations. 1937. Bologna: Licinio Capelli. L. 35.

THIS monograph, from Professor Donati's clinic, deals with a careful study of 180 cases of cancer of the breast, of which 165 were operated upon.

Mortality in Italy has steadily risen, from the beginning of the century up to 1934, from 5·47 to 9·84 per 100,000. In this clinic during the five-year period in which the 165 cancer cases were operated upon, no less than 91 fibro-adenomata were met with—surely a much higher proportion than in most clinics.

The author says little about irradiation as the sole treatment of breast cancer, though Professor Perussia, also of the University of Milan, has not neglected the subject. The figures quoted in support of post-operative irradiation as a potent means of prolonging survival are striking.

There is a notable histological study of all the cases, and Dr. Coggi truly says that the real interest of such studies is for prognosis.

The conclusion to which he comes, after a review of the literature and his own work, is, however, that the histologist must possess a flair for analysing all the data, and synthesizing a multiplicity of indications. For the rest, the volume is mainly a summary of recent, and some not so recent, opinions of distinguished surgeons and pathologists the world over.

Mecanismo probable de la Cancerización. By AMÉRICO GARIBALDI. In two volumes. 10 × 7 in. Pp. 608 + xxxii, with illustrations. 1936. Lima (Peru): Facultad de Ciencias medicas, Universidad Mayor de San Marcos.

THIS immense "essay" in pathogeny provides a gargantuan meal for those whose appetite has not been impaired by attempts to swallow all that has been written on the causation of cancer, and upon possible methods of preventing and treating it, during the last twenty-five years.

There is hardly a theory—plausible, fanciful, or well-founded—that is not here considered ; hardly a study—physical, chemical, electronic, or infective—to which allusion is not made. In such matters it is a work of reference—lacking an index—that can hardly fail, for the bibliographies are immense.

When it comes to the author's own theory of causation and to the system of medical treatment by which he hopes to eliminate the knife and irradiation, it must be admitted that for all his erudition and industry, he helps the reader but little. The parturient mountain brings forth a very curious mouse. Professor Garibaldi is eclectic. His theory, so far as may be understood, is a combination or fusion of most of the theories he has exposed, and his treatment seems to savour of the medieval spirit, whose prescriptions left nothing to chance where multiplicity of ingredients could ensure success.

He does not claim to have found a cure, but he looks forward to its accomplishment—to-morrow.

The Adrenal Cortex and Intersexuality. By L. R. BROSTER, CLIFFORD ALLEN, H. W. C. VINES, JOCELYN PATTERSON, ALAN W. GREENWOOD, G. F. MARRIAN, and G. C. BUTLER. With a Foreword by Sir WALTER LANGDON-BROWN. Demy 8vo. Pp. 245 + xii, with several illustrations. 1938. London: Chapman & Hall. 15s. net.

SIR WALTER LANGDON-BROWN introduces this monograph by paying tribute to the work of the authors and particularly Dr. Vine's discovery of the fuchsin-staining adrenal cortical cell as evidence of virilism, an observation which he states has been repeatedly confirmed and can now be accepted as proved. The book is dedicated to Lord Wakefield, who provided the assistance for much of the research work on which it is based.

The study of virilism and its association with adrenal hyperplasia has thrown light on the nature of sexuality, and among other things demonstrated that it is not just a question of chromosome endowment and such a simple matter as some geneticists would have us believe. Neither is it, as some endocrinologists would try to persuade us, entirely one of hormonal influence. Although hormones may play the part of reinforcing psychical sexual patterns, they are apparently not the initiators of those patterns ; but, as may be seen from reading this work, the whole question is both complex and fascinating. This may of course be said of all problems relating to the primary instincts, and particularly that which many regard as the most potent of all of these.

The contributors to this volume discuss their subject from four different aspects, viz., clinical and surgical, psychological, pathological, and biochemical. They do so in a work of convenient size and of clear readable type, illustrated by numerous photographs, which, except for some drawings of surgical instruments, depict clinical features only and are photographs of actual cases. We were disappointed that there were not some illustrations of other aspects of the subject, particularly some microphotographs in the pathological section, and we should have liked to see some coloured illustrations of the staining reactions. A list of references after each section comprises a useful bibliography, but in addition to the general index, which is far from complete, a separate index of the authors referred to would be a valuable addition to a future edition.

The relation of adrenal hyperplasia to Cushing's pituitary basophilism is considered, and the interesting conclusion reached that in Cushing's syndrome the adrenal cortex is definitely involved and that there is a reciprocal relationship between the cortex and the pituitary, so that a syndrome similar to Cushing's may be caused, irrespective of which gland is primarily diseased.

To physicians, psychiatrists, and, we might almost say, practitioners of all kinds, this valuable little monograph should appeal, but considerations such as the selection of suitable cases for adrenalectomy and the technique of the operation make it attractive to surgeons. It is of interest to note that Broster has abandoned the transthoracic route to the adrenal for a sub-diaphragmatic approach. For surgeons perhaps the chief value of this work lies in the fact that it summarizes the present position of our knowledge of the part which the adrenal cortex plays in the determination of sexual characteristics, and of the possibility of influencing these by its ablation.

Genital Abnormalities, Hermaphroditism, and Related Adrenal Diseases. By HUGH HAMPTON YOUNG, M.A., M.D., Sc.D., F.R.C.S.I., D.S.M., Professor of Urology, The Johns Hopkins University, etc. 10¼ × 6¾ in. Pp. 650 + xlii, with 379 illustrations. 1937. London: Baillière, Tindall & Cox. 45s. net.

IT has been a matter of conjecture as to which branch of surgery—apart from General Surgery—would be first to adopt the adrenal cortex. This has now been settled by the urologists in a new publication by Dr. Hugh Young on *The Genital Abnormalities, Hermaphroiditism, and Related Adrenal Diseases*. Dr. Young is to be congratulated upon his enterprise, which is a true reflection of the vigour and vitality of the Johns Hopkins School of Medicine. He has been quick in grasping, what others have been slow to recognize, the profound effect which the adrenal cortex exerts on genital development, and in translating it to such practical purpose. In this respect the urologists have justly staked a large claim, but it must be remembered that the study of the adrenal is such a wide one that it transgresses the bounds of any one speciality and encompasses the study of endocrinology as a whole, and the specialities of biochemistry, psychiatry, gynæcology, and to a lesser extent neurosurgery. It is not until all these branches of medicine have had their say, not only in confirming what has already been done but in adding their own special knowledge, that any general advance can be made.

This book comprises some 600 pages mainly devoted to plastic operations on the genitalia, and is profusely and well illustrated. It cannot be said that it is distinguished by any form of original research of such a kind as to further our knowledge or by new theories to excite our interest in those early biological problems on sex development about which so little is at present known. The clinical part is very fully discussed, and all the operative details are profusely illustrated. To begin with there is an interesting chapter on hermaphroditism in reference to literature and art. A series of 53 cases is quoted, and in each group there is a comprehensive survey of the literature of similar cases. The details of some of the cases also call for comment. In *Case* 9, in which partial bilateral resection of the adrenal glands in 1933 for female pseudohermaphroditism was followed by good results, the urinary œstrin was found to be very high and was considerably reduced after operation. In the comments on the case it is stated that "the secretion of the female gonads was not sufficient to arrest the growth of the phallus", and later, "in view of the subsequent cases it seems more correct to attribute pseudohermaphroditism in this case to adrenal cortical hyperplasia, which inhibited the development of the ovary, which in turn produced the abnormalities described". It has been known that cystic degeneration of the ovaries is constantly present in these cases, and this is probably secondary to the adrenal hyperplasia, but apart from a variable loss of function, there is nothing to indicate that the ovaries play any part in the evolution of the syndrome.

With regard to the adreno-genital syndrome, Dr. Young has introduced a technique of bilateral exposure with removal of portions of each adrenal. His contention for doing this is that he finds abdominal palpation of these glands unsatisfactory, and dispenses with a preliminary laparotomy. This method appears serviceable for straightforward cases of virilism, but does not recommend itself as a matter of routine. A preliminary laparotomy is sometimes essential in order to settle diagnosis, especially in intersex individuals, as it enables the surgeon not only to verify the adreno-genital syndrome by the study of the pelvic organs but to eliminate the presence of accessory adrenals, and to establish a differential diagnosis from sex changes due to hypothalamic tumours, when neurological symptoms are absent. Mistakes are bound to be made if it is dispensed with, and the adrenals can be felt adequately in the majority of cases. For instance, in *Case* 23 the diagnosis of arrhenoblastoma of the ovary could have been established and the patient cured by one operation. Bilateral interference with the adrenal glands is perhaps too recent an operation to allay the suspicion of Addison's disease supervening.

The subject is still a young field of surgical endeavour, and its progress, which has been rapid, is difficult to evaluate at present. The march of time will settle this. To those workers interested in these fundamental biological problems, we can heartily recommend this book.

Synopsis of Genito-urinary Diseases. By AUSTIN I. DOBSON, M.D., F.A.C.S., Professor of Genito-urinary Surgery, Medical College of Virginia, etc. Second edition. $8\frac{3}{4} \times 5\frac{1}{8}$ in. Pp. 294, with 112 illustrations. 1937. London: Henry Kimpton. 12s. 6d. net.

THIS is an attractive summary of urology, well printed and clearly written. To compress so much information within the space of 294 pages must be a handicap, but the author's knowledge of his subject is accurate and up to date.

On the very few occasions on which Dr. Dodson has allowed himself to be reminiscent, as apropos of cases of dislocation of the penis and of a punctured wound of the bladder, the reader's interest is much stimulated; we venture to suggest that the value of a third edition would be enhanced by giving more instances from his great experience, though at the cost of making the work larger and more expensive.

Many of the illustrations are borrowed, and some are diagrammatic, but they are well reproduced and of use in explaining the text. A few, such as the pictures of tumours of the bladder, are very poor, and much below the standard we now expect from transatlantic surgeons. In future editions we hope he will no longer spell the name of a French urological star of the first magnitude as Alboran; there is surely no excuse for a surgeon who specializes in urology to be ignorant of the real name of the great J. Albarran.

Der Schock und verwandte Zustände des autonomen Systems. By Prof. Dr. EDUARD REHN, Freiburg. Heft 16 of *Vorträge aus der praktischen Chirurgie* (Lexer). Large royal 8vo. Pp. 42. 1937. Stuttgart: Ferdinand Enke. Paper covers, RM. 2.60.

IN this review of surgical shock Professor Rehn has used exclusively the data which he has accumulated as the result of his investigations on human patients. Almost at the outset he makes the statement that experimental work on animals does not throw much light on this condition. With this opinion those who are acquainted with the literature will disagree, and it is obvious from a careful study of his own paper that many of his conclusions are based on the results of animal experiments by others.

Professor Rehn discards the toxic theory, but is apparently unaware of recent work which has shown this theory to be false. Again, the factor of fluid loss, which so many British and American workers have investigated, is not discussed with reference to these published results. The author has shown quite conclusively that the most striking feature of all shock conditions is a fall in the quantity of blood actually in circulation. It must be pointed out here that this does not imply that the patient is in need of fluid, for the author has shown that the patient (except in cases of severe hæmorrhage accompanying shock) is often able to provide the necessary fluid from his own tissues and the blood stores. Professor Rehn takes great pains to point out that the fall in circulating blood volume is the result of 'shock' and not the cause of it. The actual cause of shock he considers to be a profound disturbance of automatic function, probably of nervous origin, but if he had been familiar with experimental work done in this country he would have been convinced that his hypothesis rested on a sure basis.

Many pages are devoted to the results of investigations into the alkali reserve of the body. It is stated that diminished alkali reserve is almost as good an index of the degree of shock as the fall in circulating blood volume. This conclusion was reached many years ago by the war-time Shock Commission, but no mention is made of these results. The diminished alkali reserve is, of course, a necessary corollary to the fall in circulating blood volume, and is a measure of the amount of deprivation of oxygen in the tissues.

Professor Rehn's review is of great interest, as it arrives at an identical conclusion with that reached by experimental methods in this country, but it is marred by lack of attention to contemporary literature and by the absence of a bibliography.

Disability Evaluation. Principles of Treatment of Compensable Injuries. By EARL D. MCBRIDE, B.S., M.D., F.A.C.S., Assistant Professor of Orthopedic Surgery, University of Oklahoma School of Medicine; etc. Second edition. 9×6 in. Pp. 623 + xvi, with 374 illustrations. 1938. London: J. B. Lippincott Co. 38s. net.

THE second edition of this book does not differ from the first, except that the laws of the individual States have been brought up to date.

Surface and Radiological Anatomy. For Students and General Practitioners. By ARTHUR B. APPLETON, M.A., M.D. (Cantab.), Professor of Anatomy in the University of London and Director of the Department of Anatomy in the Medical School of St. Thomas's Hospital; WILLIAM J. HAMILTON, M.D., B.Ch. (Belf.), D.Sc. (Glas.), F.R.S.E., Professor of Anatomy in the University of London at the Medical College of St. Bartholomew's Hospital; and IVAN C. C. TCHAPEROFF, M.A., M.D., B.Ch. (Cantab.), D.M.R.E., Assistant Radiologist at St. Thomas's Hospital, London. 9⅜ × 6½ in. Pp. 311 + xii, with 338 illustrations, some coloured. 1938. Cambridge: W. Heffer & Sons Ltd. 15s. net.

THE authors are to be congratulated on the issue of this charming and finely illustrated volume; they have been successful in condensing an immense amount of accurate and up-to-date information into some three hundred pages.

They justify the inclusion of what may be called 'radiological anatomy' on several grounds. They point out that a knowledge of the normal as seen by the X rays is quite indispensable to their correct utilization for clinical purposes; that radiology emphasizes the distinctive features of the living subject as contrasted with those of the cadaver; and that it directs attention to the differences between individuals and to those which are found in the same subject under varying conditions. With these remarks every surgeon who has watched the extraordinary development of X-ray technique during the last twenty-five years must agree; nowhere is this more obvious perhaps than in the radiology of the stomach.

One of the most striking sections of the book is that which deals with the anatomy of the thorax; in this the radiographs of intrathoracic structures are explained and illuminated by illustrations and diagrams which show the changing relations of the organs as the X-ray tube is shifted through various angles. Personally, we find this the most valuable part of the book.

All the surface anatomy is excellently described, and the pictures of the muscle contours are beautifully drawn; they are accompanied by illustrations of the muscles in question.

The numerous X-ray films are so clearly reproduced that the assurance of the authors that "they are completely untouched" seems almost superfluous.

The one criticism we venture is that the letterpress, though clear and singularly free from misprints, is so small as to make reading rather tiring.

We heartily recommend this volume to our readers and again compliment the authors on a very fine and painstaking piece of work.

A Bibliography of the Works of Ambroise Paré: Premier Chirurgien E Conseiller du Roy. By JANET DOE, Assistant Librarian of the New York Academy of Medicine. 10½ × 7½ in. Pp. 265 + xx, with 29 illustrations. 1937. Chicago: University of Chicago Press. (London: Cambridge University Press.) 22s. 6d. net.

MANY persons think that a hand list is the same thing as a bibliography, though the two are entirely distinct. A hand list is just a dry catalogue which can almost be compiled from the title pages of the books with which it deals. A bibliography is a much more serious business and must be undertaken as a labour of love by some one who has chosen his subject from a personal motive. The bibliographer is ready to devote much time to the work. He first finds out all that is known previously about the man he has chosen and then proceeds to discuss what he has written, when he wrote, and what changes occurred in the various editions published during his lifetime and after his death. Such a bibliography Miss Janet Doe has prepared for Ambroise Paré, the father of French surgery, who delivered the art from its medieval entanglements. She has produced a most admirable and satisfying volume. As assistant Librarian at the New York Academy of Medicine she has had access to the chief editions of Paré's works, but she has not been contented with making a careful study of them alone. She has tracked down every known and some hitherto unknown editions, has collated them by personal inspection, and states where they are to be found. As a graceful compliment and a well-deserved honour she has in the main followed the method adopted by Mr. Geoffrey Keynes in his bibliography of Dr. William Harvey.

The publishers, too, have done their share well. The book is printed on good paper and the illustrations are most satisfactorily rendered. The bibliography can be highly recommended to every surgeon who wishes to know how Paré came to occupy the position he still holds as a master in the craft.

Transactions of the Institute of British Surgical Technicians. Demy 4to. Vol. I, pp. 72; Vol. II, pp. 93. 1937. London. Each vol., 30s. net.

THIS publication marks the initiation of a new corporation of surgical craftsmen which should have the warm sympathy and encouragement of the surgical profession. The Institute aims at forming a corporate body to whom the legislature can apply in various enactments which seek to control the sale, supply, and standardization of surgical appliances. But it also aims at setting up a standard of ethics and education for those engaged in, or entering upon, the surgical instrument makers' business.

The first two volumes of the transactions, besides setting out the rules, regulations, and objects of the new Institute, provide a number of articles of great surgical interest, e.g., one on stainless steel by Dr. Hatfield, and one on the preparation and sterilization of catgut by Sir Weldon Dalrymple-Champneys.

There is also an account of the enthusiastic election of Mr. H. S. Souttar as Honorary President, together with his very interesting address on the technicalities of surgical manufacture, of which he is a master. We warmly welcome this new Institute and its publication, though we are constrained to wonder at the rather prohibitive price of the volumes.

BOOK NOTICES

[The Editorial Committee acknowledge with thanks the receipt of the following volumes. A selection will be made from these for review, precedence being given to new books and to those having the greatest interest for our readers.]

Die Ernährungsbehandlung in der Chirurgie. By Dr. ARNO SILLER, München. Heft 21 of *Vorträge aus des praktischen Chirurgie* (Lexer). Large royal 8vo. Pp. 39. 1938. Stuttgart: Ferdinand Enke. Paper covers, RM. 2.20.

The Practice of Urology. By LEON HERMAN, B.S., M.D., Professor of Urology, University of Pennsylvania Graduate School of Medicine; Urologist to the Pennsylvania Hospital and to the Bryn Mawr Hospital; etc. $9\frac{1}{2} \times 6\frac{1}{4}$ in. Pp. 923, with 504 illustrations. 1938. Philadelphia and London: W. B. Saunders Co. Ltd. 45s. net.

Illustrations of Anatomy for Nurses. By E. B. JAMIESON, M.D., Senior Demonstrator and Lecturer, Anatomy Department, University of Edinburgh. $8 \times 6\frac{1}{4}$ in. Sixty-two plates, 59 of which are from the Author's *Illustrations of Regional Anatomy*. 1938. Edinburgh: E. & S. Livingstone. 7s. 6d. net, postage 6d.

A Manual of Surgery for Nurses. By CHARLES WELLS, M.B., F.R.C.S., Hon. Surgeon with charge of Out-patients, Royal Southern Unit of the Royal Liverpool United Hospital; etc. Cr. 8vo. Pp. 409 + viii, with 159 illustrations. 1938. Edinburgh: E. & S. Livingstone. 10s. 6d. net, postage 6d.

Hernia: Anatomy, Etiology, Symptoms, Diagnosis, Differential Diagnosis, Prognosis, and the Operative and Injection Treatment. By LEIGH F. WATSON, M.D., Member of Attending Staff of California Lutheran Hospital and Methodist Hospital of Southern California, Los Angeles. Second edition. Large royal 8vo. Pp. 591, with 281 illustrations. 1938. London: Henry Kimpton. 31s. 6d. net.

Die Kriegsschussverletzungen der Gelenke und Knochen der Gliedmassen. By Prof. D. KARL FRANZ. Heft 18 of *Vorträge aus der praktischen Chirurgie* (Lexer). Large royal 8vo. Pp. 30. 1938. Stuttgart: Ferdinand Enke. Paper covers, RM. 1.80.

Wundversorgung und Wundbehandlung. By Prof. Dr. HANS VON SEEMEN, Munich. Heft 19 of *Vorträge aus der praktischen Chirurgie* (Lexer). Large royal 8vo. Pp. 66. 1938. Stuttgart: Ferdinand Enke. Paper covers, RM. 4.60.

Hæmorrhoids. By MARION C. PRUITT, M.D., F.R.C.S. Ed., F.A.C.S., President, American Proctologic Society; Associate in Surgery, Emory University School of Medicine, Atlanta, Georgia; etc. 10 × 7½ in. Pp. 170, with 73 illustrations, including 7 in colour. 1938. London: Henry Kimpton. 18s. net.

Die Therapie der Thrombose. By Dr. ERNST FRIEDLÄNDER. 9⅜ × 6 in. Pp. 117, with 27 illustrations. 1938. Leipzig and Vienna: Franz Deuticke. RM. 5.40; bound RM. 6.00.

Diseases of the Thyroid, Parathyroids, and Thymus. By ANDRE CROTTI, M.D., F.A.C.S., LL.D., R.I.C.S. Third edition, revised and enlarged. 10½ × 7¼ in. Pp. 1229, with 262 illustrations and 39 coloured plates. 1938. London: Henry Kimpton. 90s. net.

Akute Gliedmassendystrophie in ihrer Bedeutung für die Behandlungsmassnahmen in der Unfallchirurgie. By B. KARITZKY, Freiburg. 9¼ × 6¼. Pp. 52. 1938. Berlin: F. C. W. Vogel. RM. 4.40.

Innere Medizin in der Chirurgie. By Doz. Dr. med. habil. H. FRH. v. KRESS, Berlin, and Dr. med. W. KITTLER, Munich. Bd. 59 of *Neue deutsche Chirurgie*. 10½ × 7⅛ Pp. 144 + viii. 1938. Stuttgart: Ferdinand Enke. RM. 10; bound, RM. 11.80.

The Foot. By NORMAN C. LAKE, M.D., M.S., D.Sc. (Lond.), F.R.C.S. (Eng.), Senior Surgeon and Lecturer on Surgery, Charing Cross Hospital; Surgeon, Bolingbroke Hospital; Director of Studies, London Foot Hospital; etc. Second edition. 8¾ × 5½ in. Pp. 366 + viii, with 113 illustrations. 1938. London: Baillière, Tindall & Cox. 12s. 6d. net.

A Textbook of Neuro-radiology. By CECIL P. G. WAKELEY, D.Sc., F.R.C.S., F.R.S.E., F.A.C.S., F.R.A.C.S. (Hon.), Fellow of King's College, London; Senior Surgeon, King's College Hospital and West End Hospital for Nervous Diseases; etc.; and ALEXANDER ORLEY, M.D., D.M.R.E., Radiologist, West End Hospital for Nervous Diseases; etc. 10¼ × 6¾. Pp. 336 + xiv, with 229 illustrations. 1938. London: Baillière, Tindall & Cox. 25s. net.

Surgical Nursing and After-treatment. By H. C. RUTHERFORD DARLING, M.D., M.S., F.R.C.S., Surgeon, Prince Henry Hospital, New South Wales Hospital (Langton Clinic), and New South Wales Masonic Hospital, Sydney. Sixth edition. 7½ × 5 in. Pp. 714 + xii, with 206 illustrations. 1938. London: J. & A. Churchill Ltd. 9s. net.

Kollapstherapie der Lungentuberkulose. By H. ALEXANDER, E. GAUBATZ, J. HEIN, W. KREMER, W. SCHMIDT, and H. WURM. Edited by W. SCHMIDT, with a Foreword by L. BRAUER and F. SAUERBRUCH. In 2 volumes. 10¾ × 7¼. Pp. 1135, with 1077 illustrations, some coloured. 1938. Leipzig: Georg Thieme. RM. 116; bound, RM. 119.

Industrial Surgery: Principles, Problems, and Practice. By WILLIS W. LASHER, M.D., F.A.C.S., Assistant Professor of Traumatic Surgery, New York Post-Graduate Medical School; etc. 9½ × 6¼ in. Pp. 452 + xxv, with 193 illustrations. 1938. New York: Paul B. Hoeber Inc. $6.00.